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Kaatz et al.

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(45) **Date of Patent: Nov. 24, 2015**

(54) **METHOD AND APPARATUS FOR PRESENTING GEO-TRACES USING A REDUCED SET OF POINTS BASED ON AN AVAILABLE DISPLAY AREA**

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(51) **Int. Cl.**

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G06T 3/40	(2006.01)
G06T 17/05	(2011.01)
G06T 11/20	(2006.01)

(52) **U.S. Cl.**

CPC ***G06T 17/05*** (2013.01); ***G06T 3/4007*** (2013.01); ***G06T 11/203*** (2013.01)

(58) **Field of Classification Search**

CPC G06T 11/206; G06T 5/00; G06T 3/40; G06T 19/00; G06T 11/20; G06T 17/05; G06T 2219/2016; G06T 15/00; G06T 11/203; G06T 3/4007; G01C 21/3626; G01C 21/3667; G01C 21/367; G01C 21/3676; A61F 2002/30943; G08G 1/0969

USPC 345/440, 419, 619, 428, 54

See application file for complete search history.

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(57) **ABSTRACT**

An approach is provided for presenting geo-traces using a reduced set of points based on an available display area. The trace platform determines a reduced set of one or more points based on an available display area of a user interface. Next, the trace platform causes, at least in part, a presentation of at least one geo-trace in the user interface based, at least in part, on the reduced set.

18 Claims, 15 Drawing Sheets

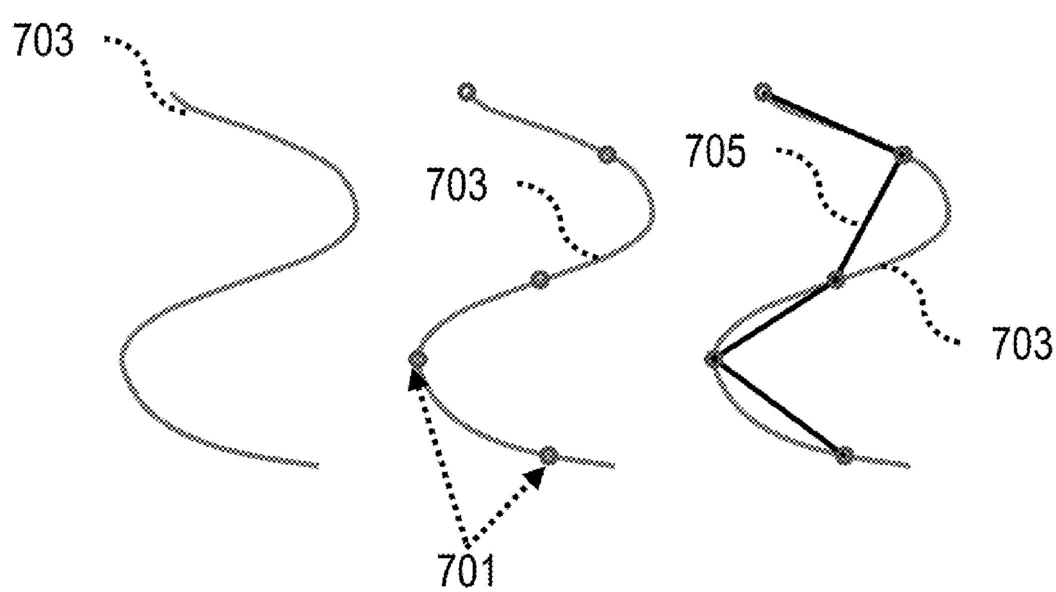
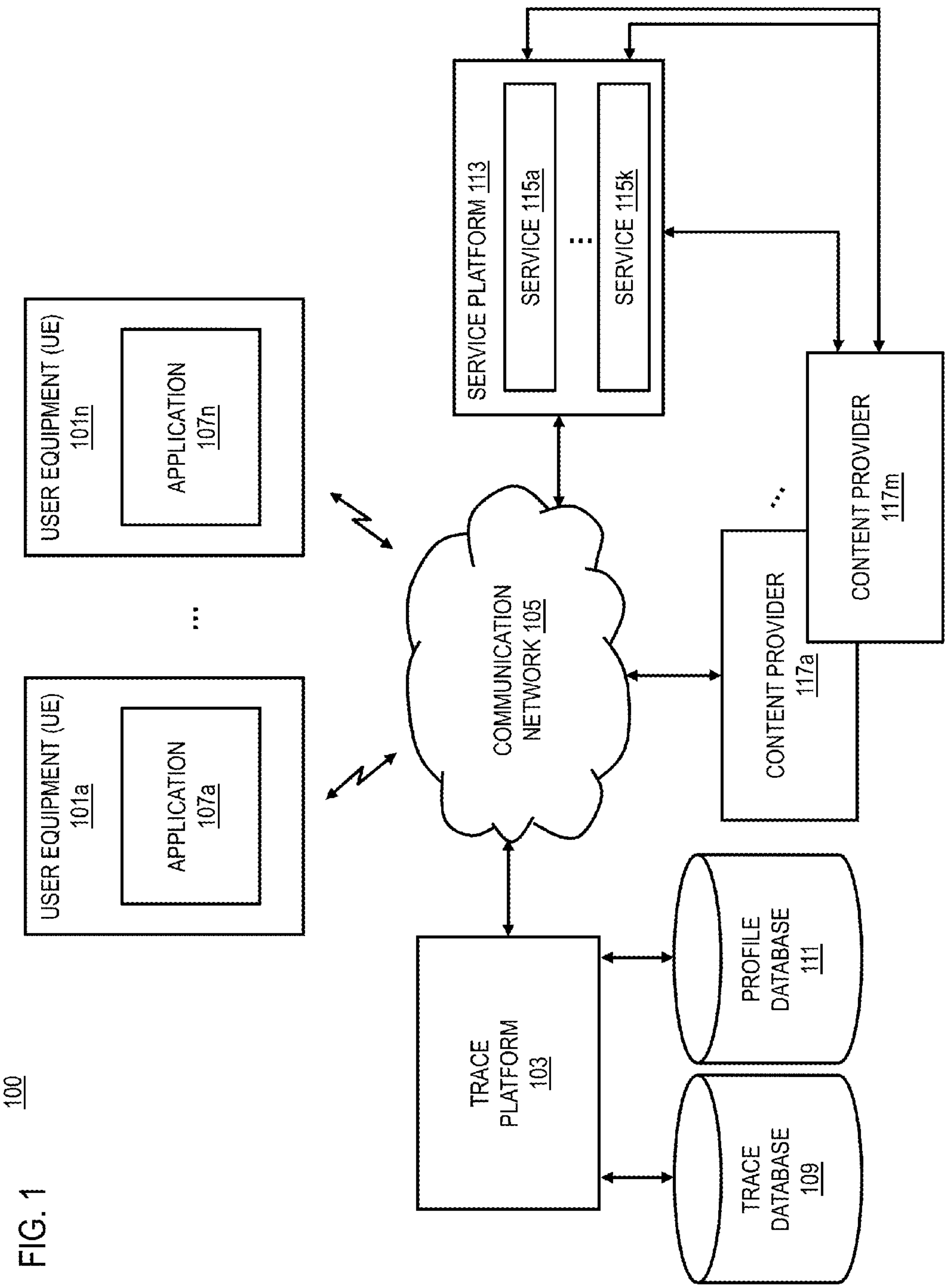


FIG. 1

100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APPLICATION 107n
USER EQUIPMENT (UE) 101a
APPLICATION 107a
SERVICE PLATFORM 113
SERVICE 115a
SERVICE 115k
COMMUNICATION NETWORK 105
CONTENT PROVIDER 117a
CONTENT PROVIDER 117m
TRACE PLATFORM 103
PROFILE DATABASE 111
TRACE DATABASE 109

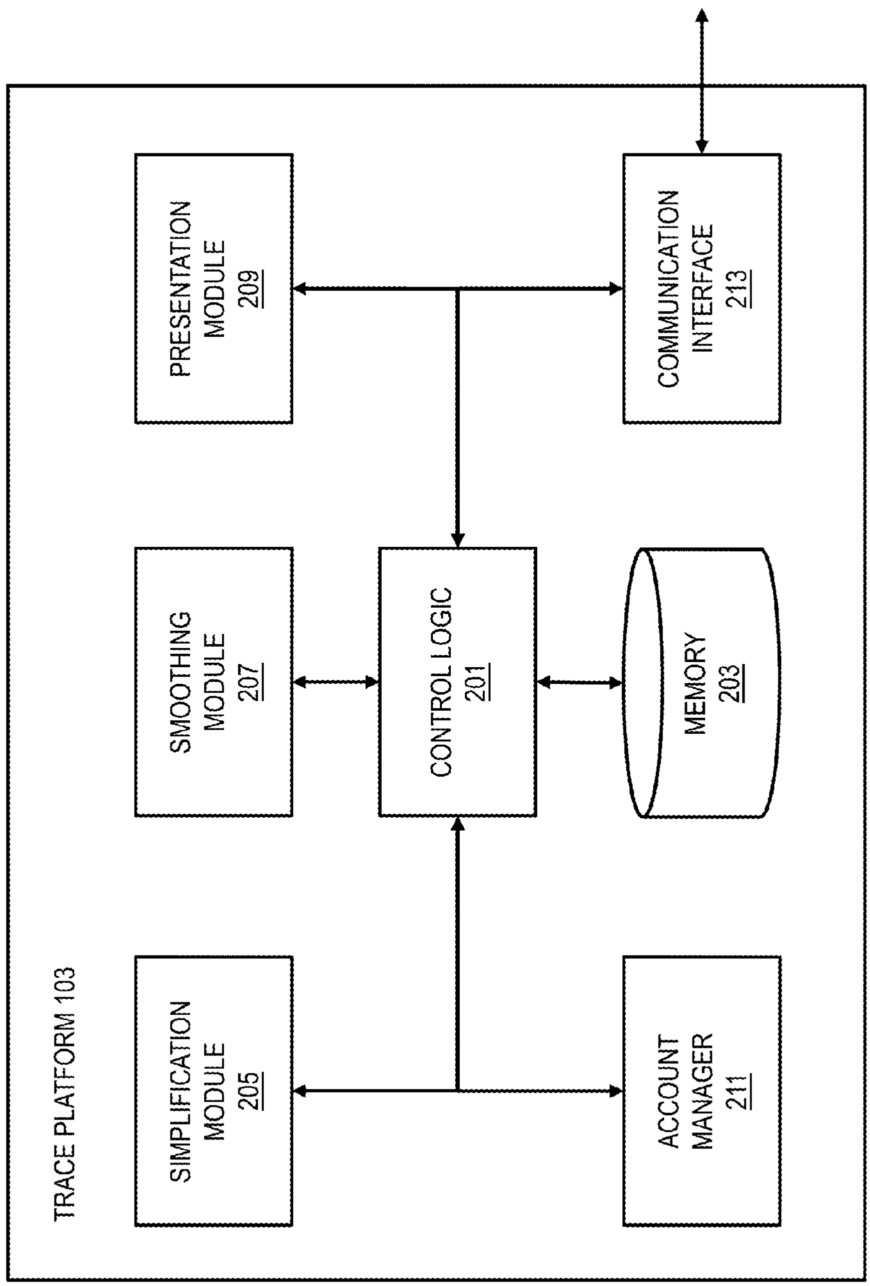

TRACE PLATFORM 103
SIMPLIFICATION MODULE 205
SMOOTHING MODULE 207
PRESENTATION MODULE 209
CONTROL LOGIC 201
ACCOUNT MANAGER 211
MEMORY 203
COMMUNICATION INTERFACE 213

FIG. 2

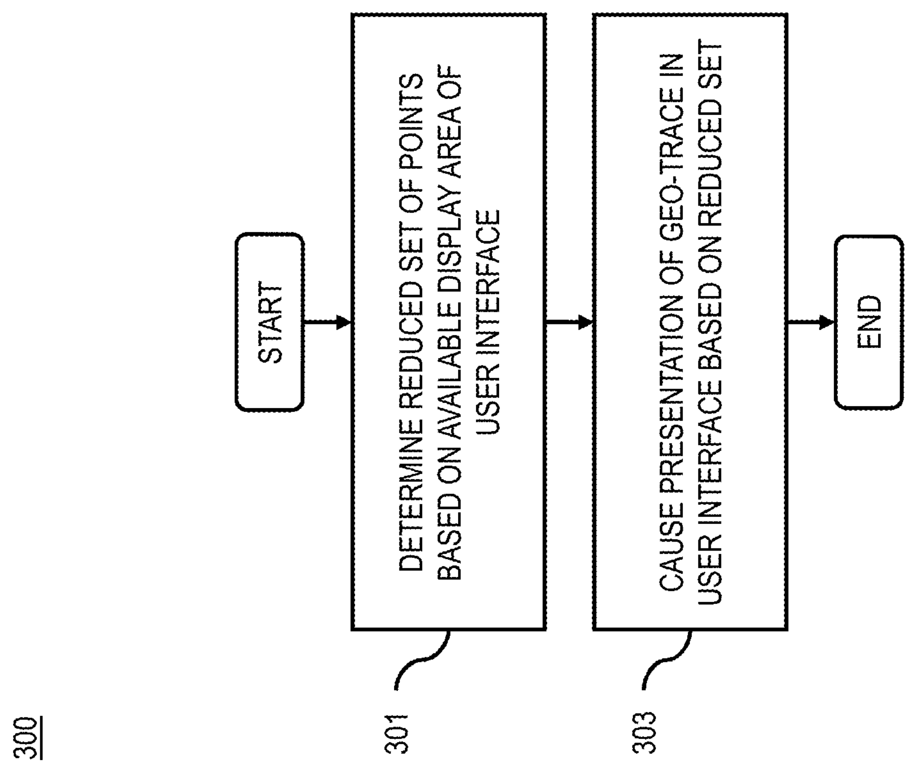

300
START
DETERMINE REDUCED SET OF POINTS BASED ON AVAILABLE DISPLAY AREA OF USER INTERFACE
301
CAUSE PRESENTATION OF GEO-TRACE IN USER INTERFACE BASED ON REDUCED SET
303
END

FIG. 3

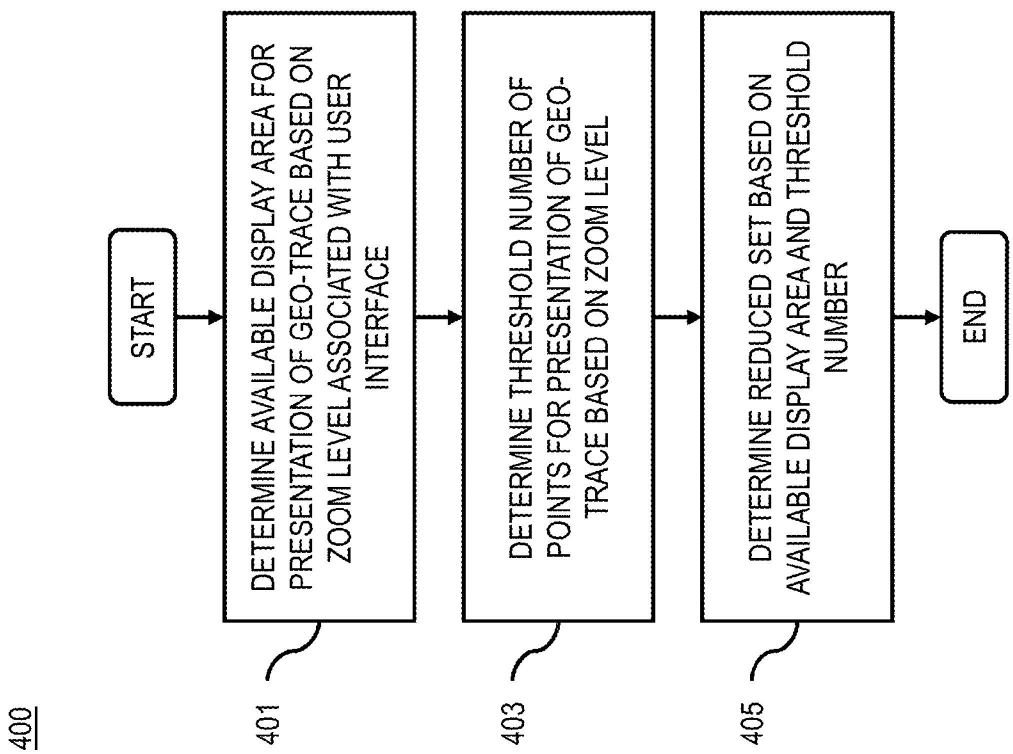

400
START
DETERMINE AVAILABLE DISPLAY AREA FOR PRESENTATION OF GEO-TRACE BASED ON ZOOM LEVEL ASSOCIATED WITH USER INTERFACE
401
DETERMINE THRESHOLD NUMBER OF POINTS FOR PRESENTATION OF GEO-TRACE BASED ON ZOOM LEVEL
403
DETERMINE REDUCED SET BASED ON AVAILABLE DISPLAY AREA AND THRESHOLD NUMBER
405
END

FIG. 4

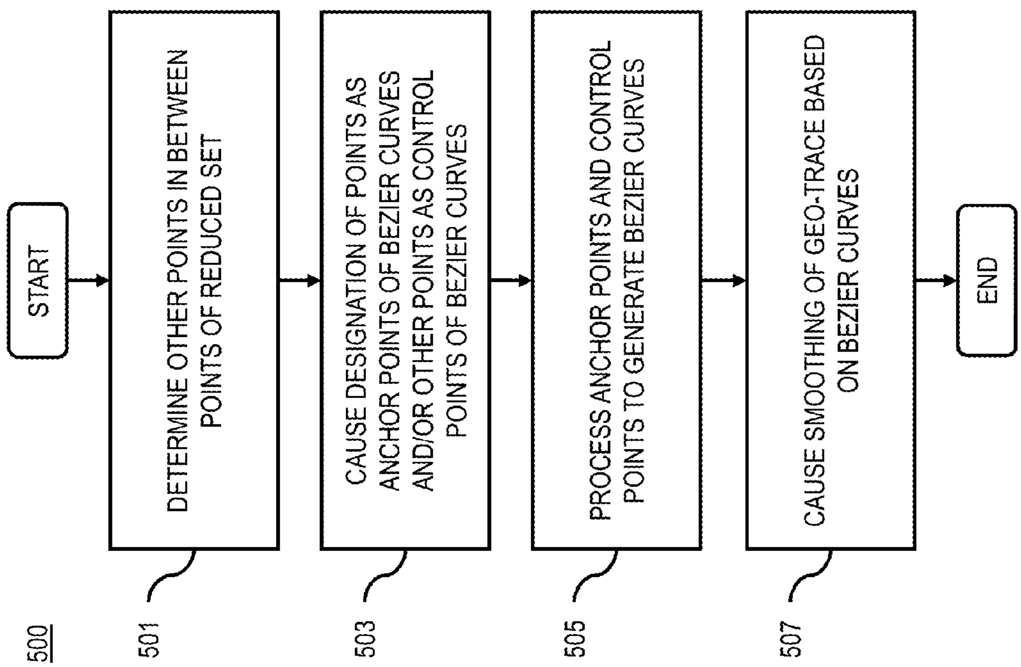

500
START
501
DETERMINE OTHER POINTS IN BETWEEN POINTS OF REDUCED SET
503
CAUSE DESIGNATION OF POINTS AS ANCHOR POINTS OF BEZIER CURVES AND/OR OTHER POINTS AS CONTROL POINTS OF BEZIER CURVES
505
PROCESS ANCHOR POINTS AND CONTROL POINTS TO GENERATE BEZIER CURVES
507
CAUSE SMOOTHING OF GEO-TRACE BASED ON BEZIER CURVES
END

FIG. 5

FIG. 6A

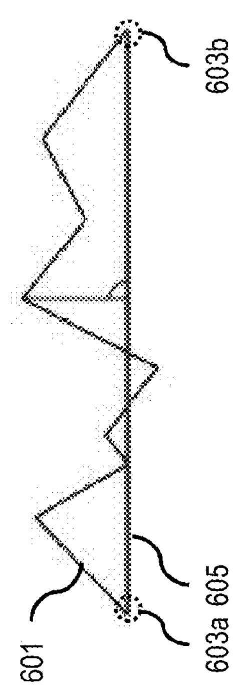


FIG. 6B

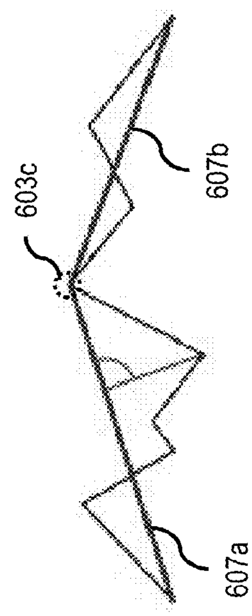


FIG. 6C

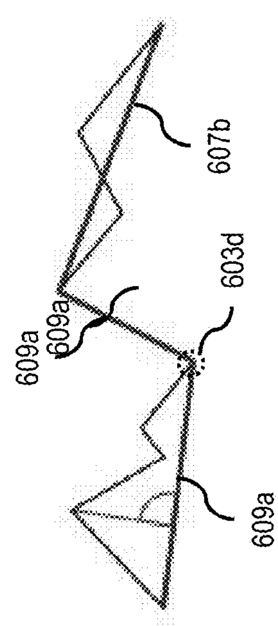
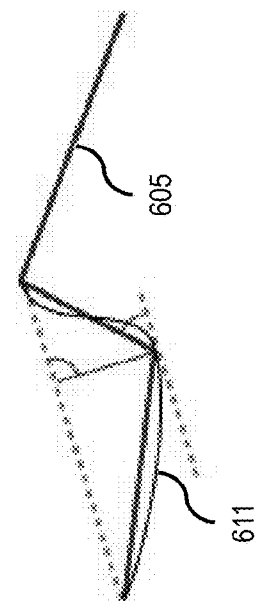


FIG. 6D



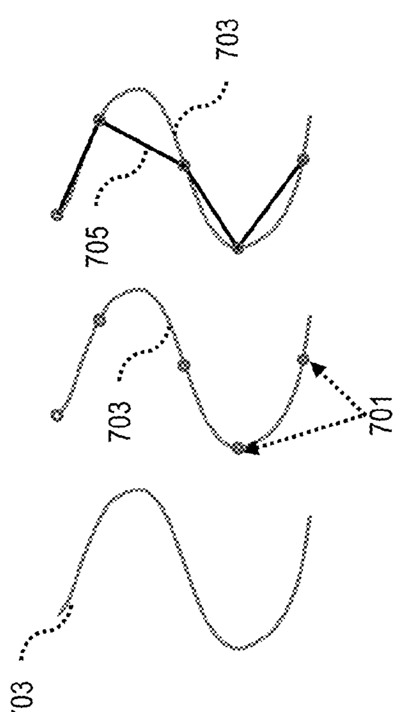


FIG. 7A

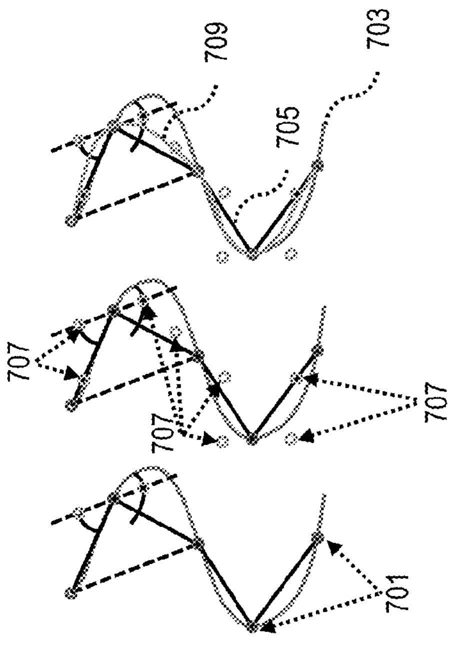


FIG. 7B

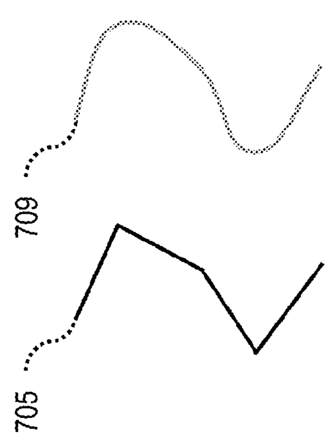


FIG. 7C

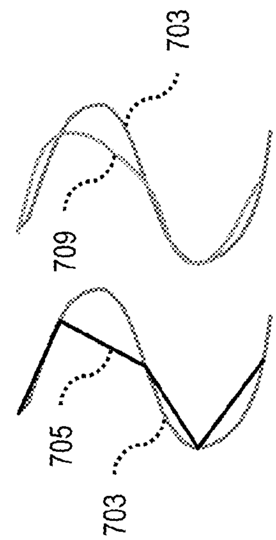


FIG. 7D

FIG. 8B

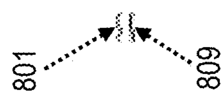
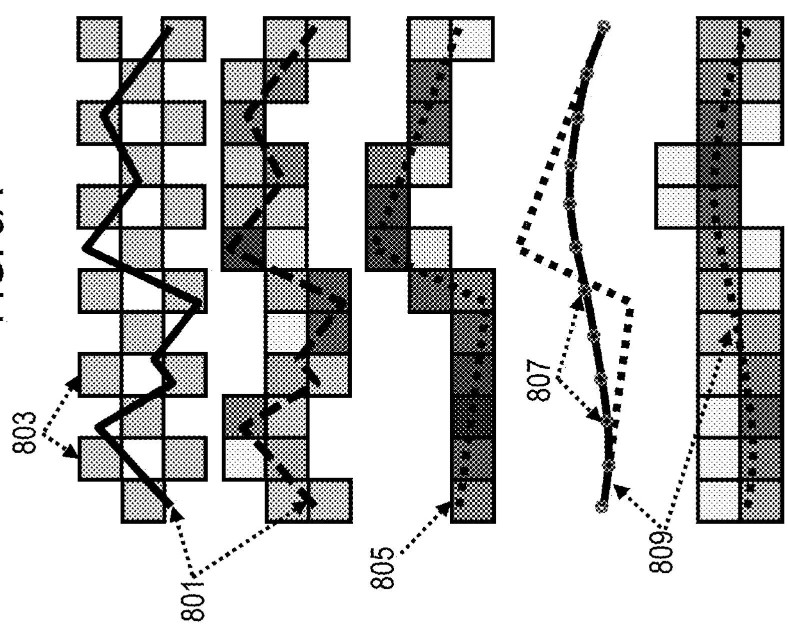


FIG. 8A



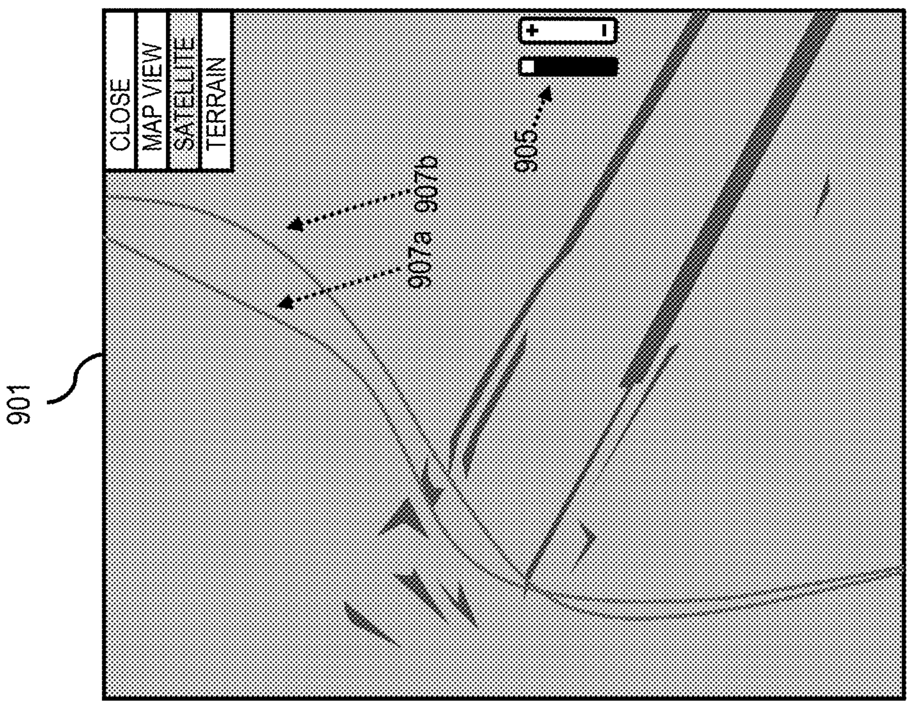

CLOSE
MAP VIEW
SATELLITE
TERRAIN
901
905
907a
907b

FIG. 9B

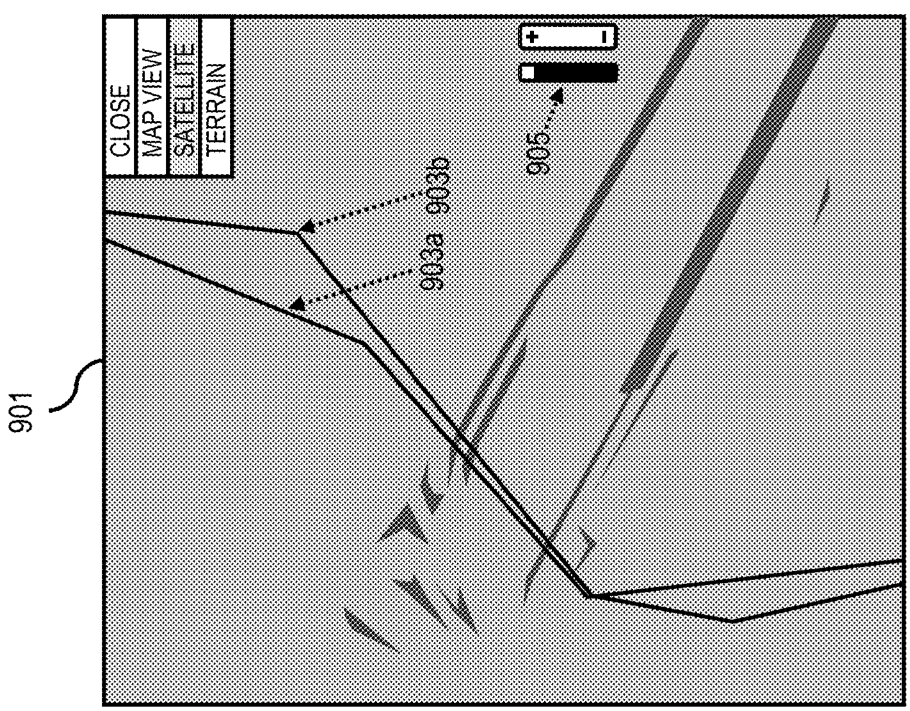

CLOSE
MAP VIEW
SATELLITE
TERRAIN
901
905
903a
903b

FIG. 9A

FIG. 10B

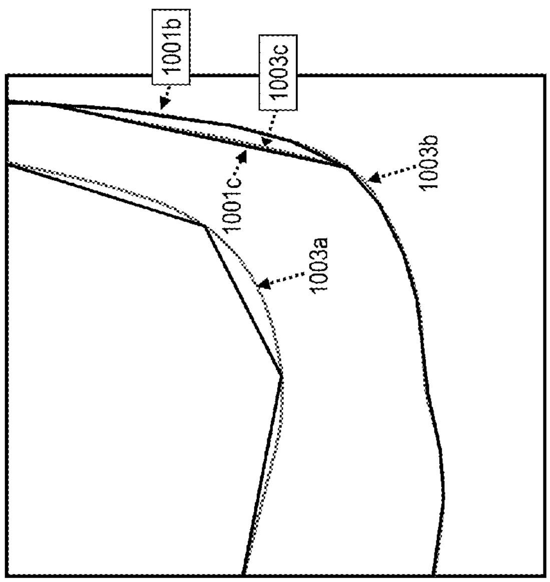


FIG. 10A

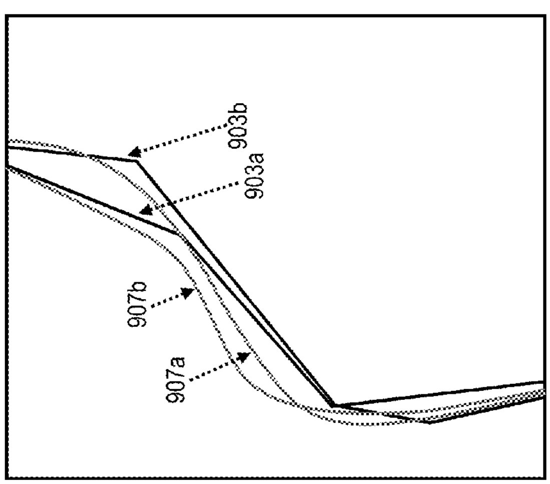


FIG. 10C

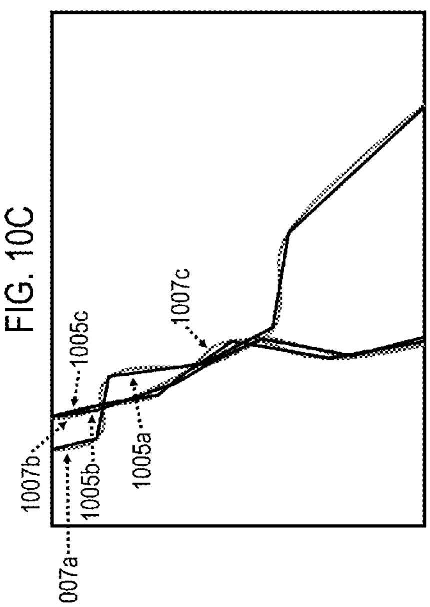


FIG. 11B

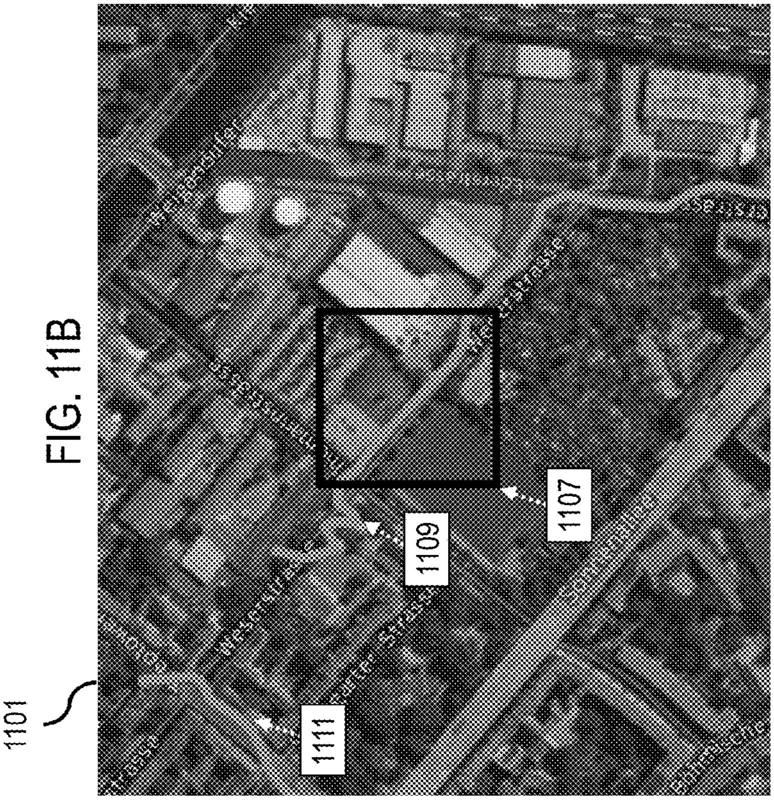


FIG. 11A

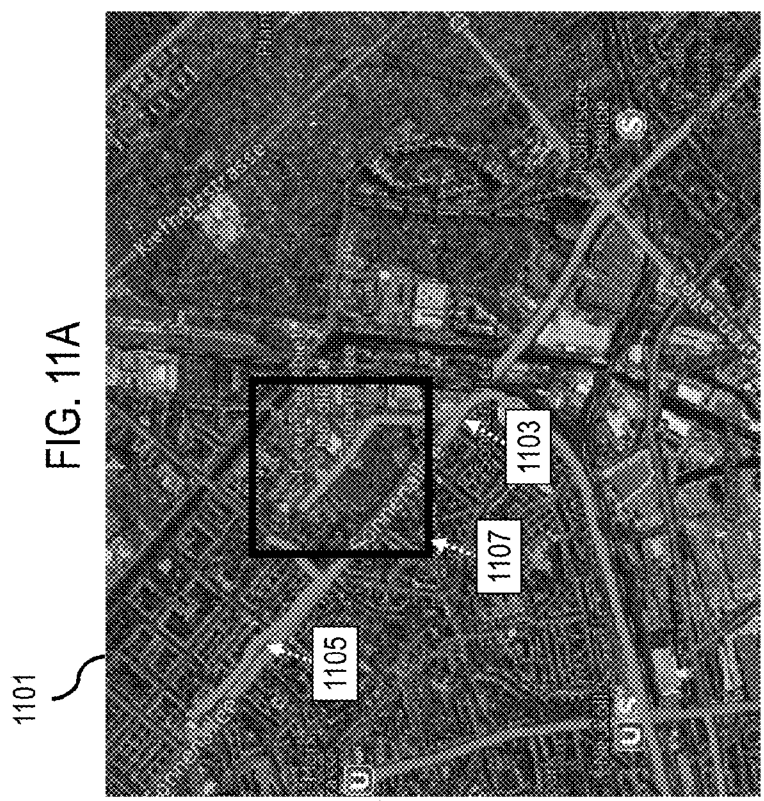


FIG. 11D

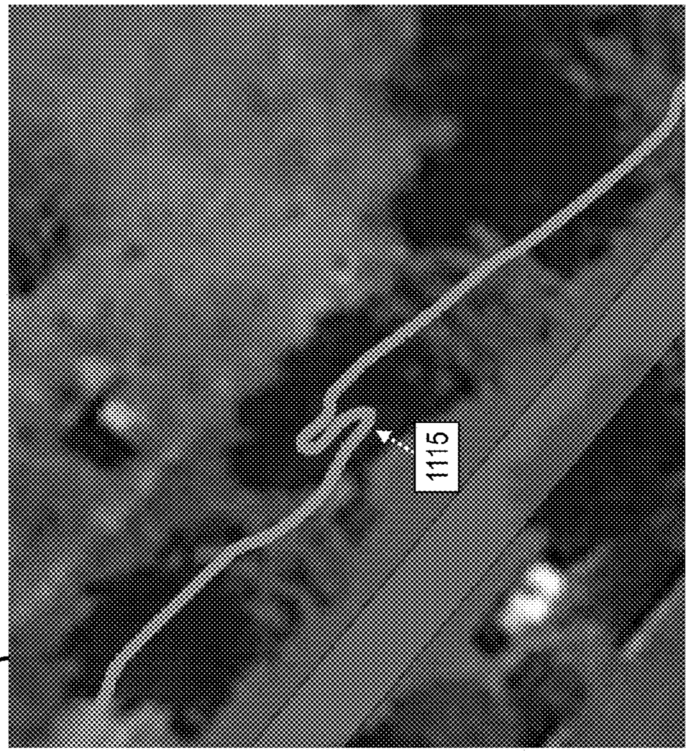
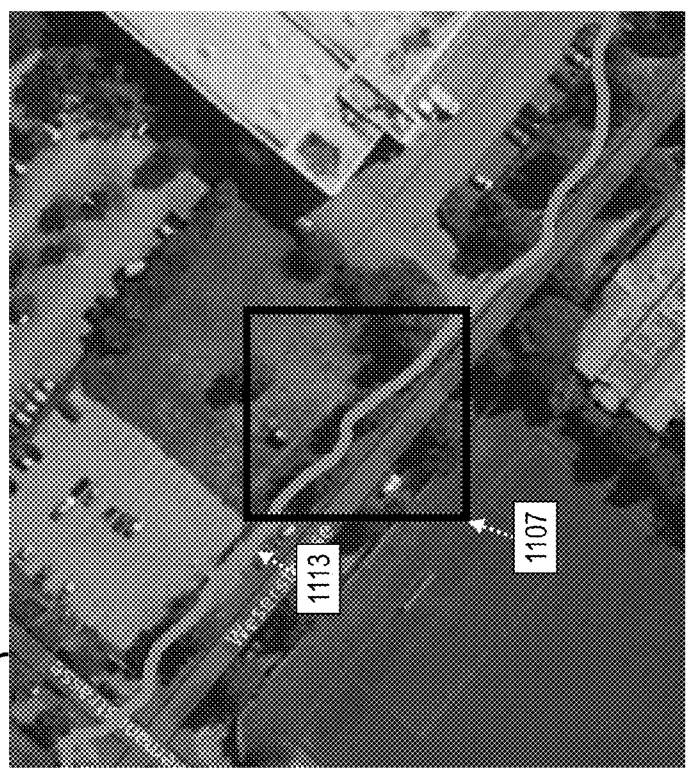


FIG. 11C



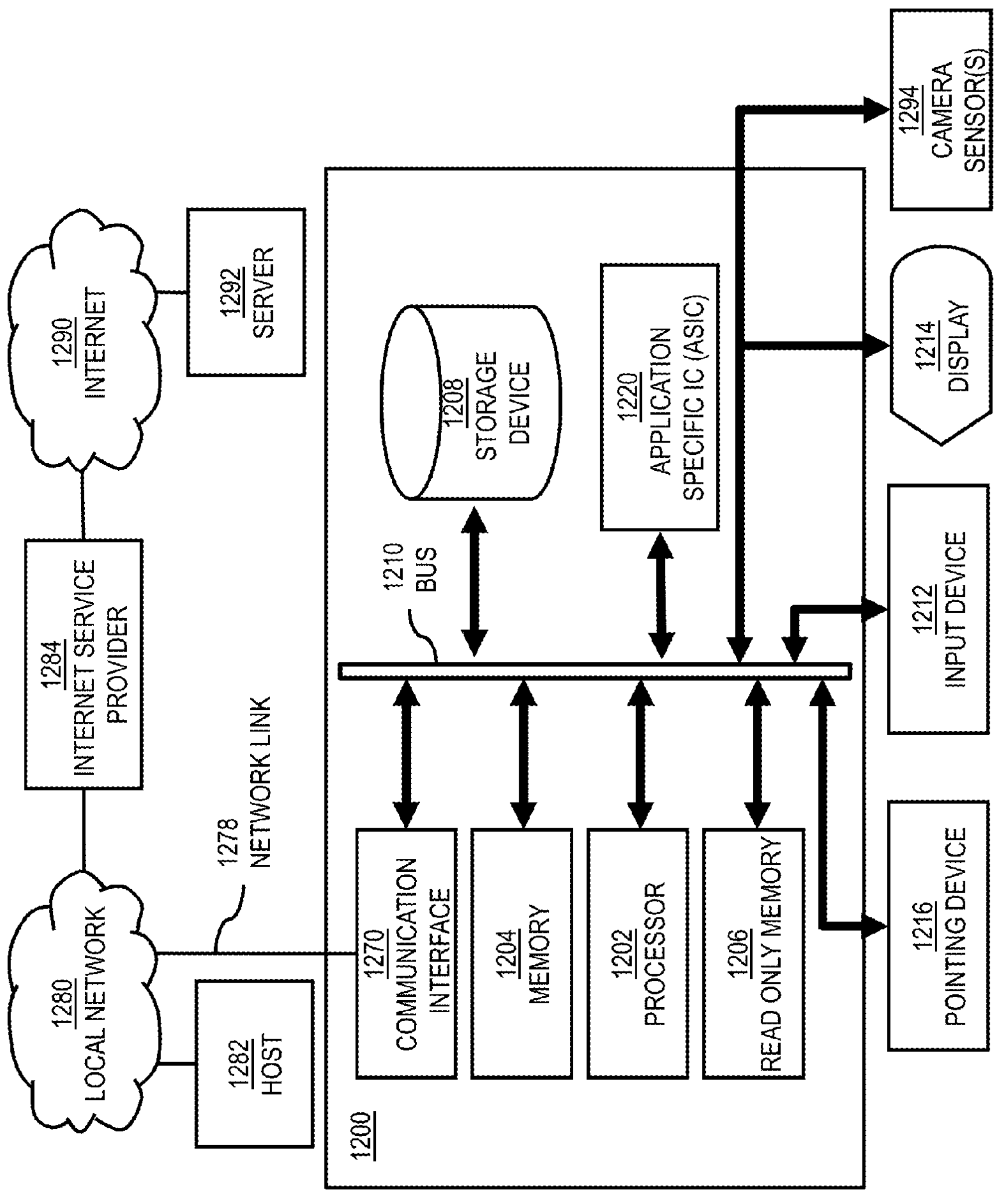

1290 INTERNET
1292 SERVER
1284 INTERNET SERVICE PROVIDER
1280 LOCAL NETWORK
1282 HOST
1278 NETWORK LINK
1200
1208 STORAGE DEVICE
1220 APPLICATION SPECIFIC IC (ASIC)
1210 BUS
1270 COMMUNICATION INTERFACE
1204 MEMORY
1202 PROCESSOR
1206 READ ONLY MEMORY
1294 CAMERA SENSOR(S)
1214 DISPLAY
1212 INPUT DEVICE
1216 POINTING DEVICE

FIG. 12

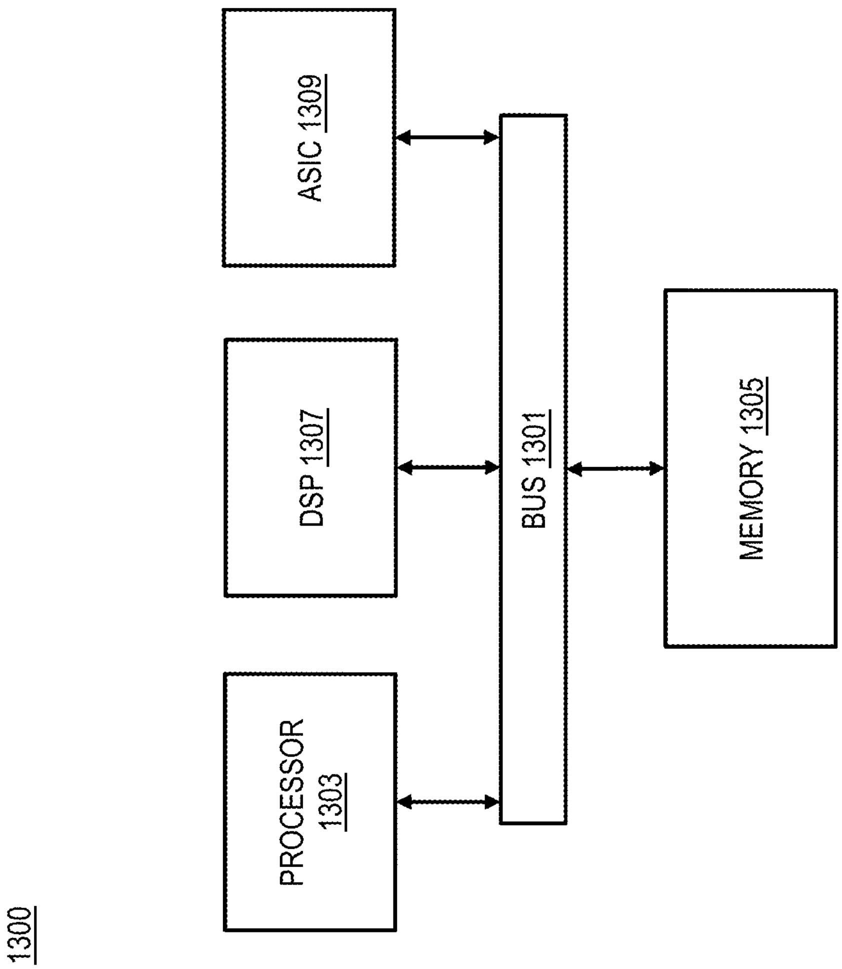
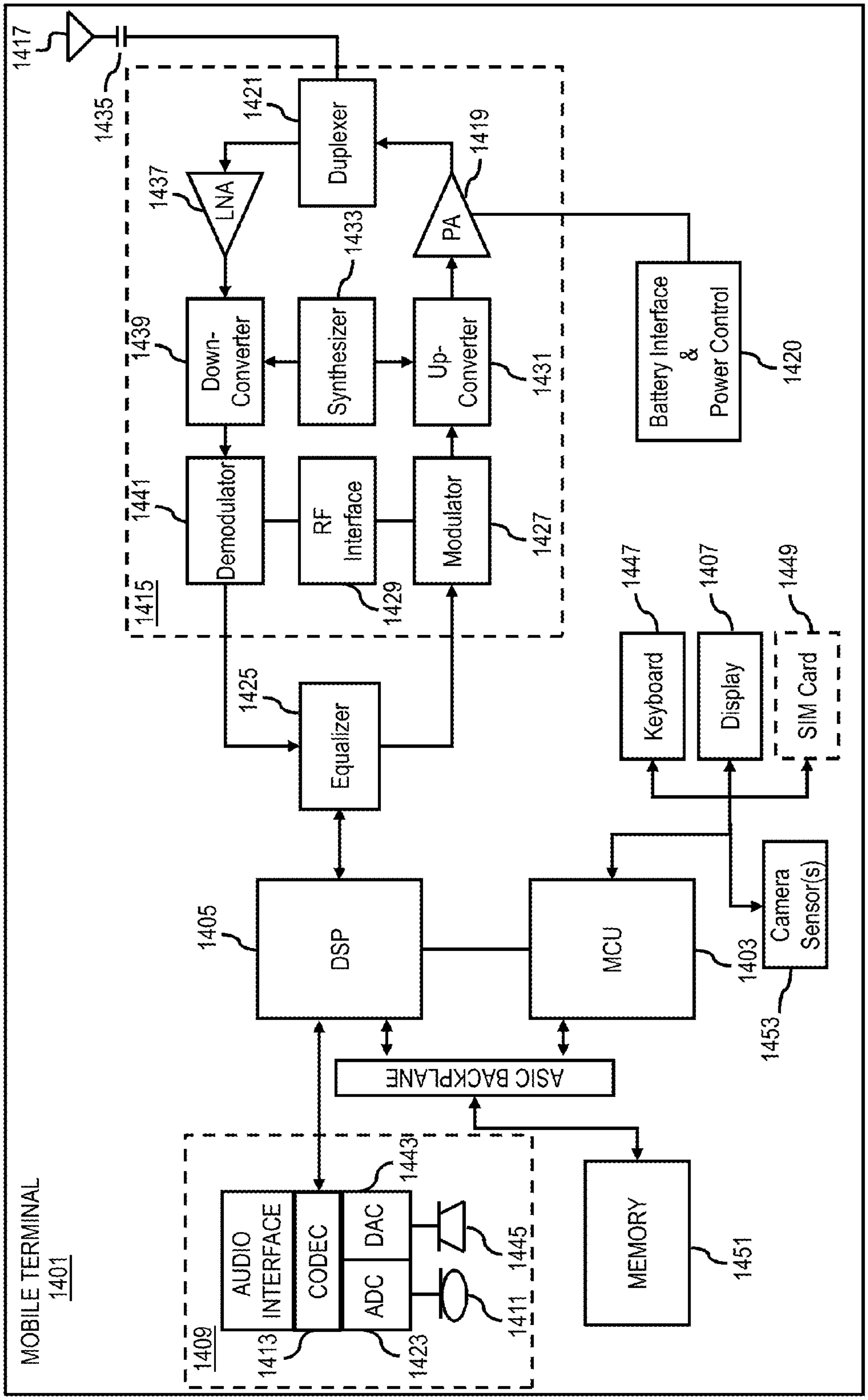


FIG. 13

FIG. 14


MOBILE TERMINAL
1401
1417
1435
1421
Duplexer
1437
LNA
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PA
1433
1439
Down-
Converter
Synthesizer
Up-
Converter
1431
Battery Interface
&
Power Control
1420
1441
Demodulator
RF
Interface
Modulator
1427
1429
1415
1425
Equalizer
1447
Keyboard
1407
Display
1449
SIM Card
Camera
Sensor(s)
1453
1405
DSP
MCU
1403
ASIC BACKPLANE
1409
AUDIO
INTERFACE
CODEC
DAC
ADC
1443
1445
1411
1413
1423
MEMORY
1451

METHOD AND APPARATUS FOR PRESENTING GEO-TRACES USING A REDUCED SET OF POINTS BASED ON AN AVAILABLE DISPLAY AREA

BACKGROUND

Service providers and device manufacturers (e.g., wireless, cellular, etc.) are continually challenged to deliver value and convenience to consumers by, for example, providing compelling network services. One area of interest has been the development of services and technologies relating to visualization of Global Positioning System (GPS) traces. For example, service providers may utilize GPS trace data to offer users a visualization of their past movements. However, typical visualizations offered by service providers may not accurately represent the actual movements, may blur the traces of the actual movements, etc., especially when there are a lot of twists and turns associated with those movements.

SOME EXAMPLE EMBODIMENTS

Therefore, there is a need for an approach for presenting geo-traces using a reduced set of points based on an available display area.

According to one embodiment, a method comprises determining a reduced set of one or more points based on an available display area of a user interface. The method also comprises causing, at least in part, a presentation of at least one geo-trace in the user interface based, at least in part, on the reduced set.

According to another embodiment, an apparatus comprises at least one processor, and at least one memory including computer program code for one or more computer programs, the at least one memory and the computer program code configured to, with the at least one processor, cause, at least in part, the apparatus to determine a reduced set of one or more points based on an available display area of a user interface. The apparatus is also caused to cause, at least in part, a presentation of at least one geo-trace in the user interface based, at least in part, on the reduced set.

According to another embodiment, a computer-readable storage medium carries one or more sequences of one or more instructions which, when executed by one or more processors, cause, at least in part, an apparatus to determine a reduced set of one or more points based on an available display area of a user interface. The apparatus is also caused to cause, at least in part, a presentation of at least one geo-trace in the user interface based, at least in part, on the reduced set.

According to another embodiment, an apparatus comprises means for determining a reduced set of one or more points based on an available display area of a user interface. The apparatus also comprises means for causing, at least in part, a presentation of at least one geo-trace in the user interface based, at least in part, on the reduced set.

In addition, for various example embodiments of the invention, the following is applicable: a method comprising facilitating a processing of and/or processing (1) data and/or (2) information and/or (3) at least one signal, the (1) data and/or (2) information and/or (3) at least one signal based, at least in part, on (or derived at least in part from) any one or any combination of methods (or processes) disclosed in this application as relevant to any embodiment of the invention.

For various example embodiments of the invention, the following is also applicable: a method comprising facilitating access to at least one interface configured to allow access to at least one service, the at least one service configured to perform any one or any combination of network or service provider methods (or processes) disclosed in this application.

For various example embodiments of the invention, the following is also applicable: a method comprising facilitating creating and/or facilitating modifying (1) at least one device user interface element and/or (2) at least one device user interface functionality, the (1) at least one device user interface element and/or (2) at least one device user interface functionality based, at least in part, on data and/or information resulting from one or any combination of methods or processes disclosed in this application as relevant to any embodiment of the invention, and/or at least one signal resulting from one or any combination of methods (or processes) disclosed in this application as relevant to any embodiment of the invention.

For various example embodiments of the invention, the following is also applicable: a method comprising creating and/or modifying (1) at least one device user interface element and/or (2) at least one device user interface functionality, the (1) at least one device user interface element and/or (2) at least one device user interface functionality based at least in part on data and/or information resulting from one or any combination of methods (or processes) disclosed in this application as relevant to any embodiment of the invention, and/or at least one signal resulting from one or any combination of methods (or processes) disclosed in this application as relevant to any embodiment of the invention.

In various example embodiments, the methods (or processes) can be accomplished on the service provider side or on the mobile device side or in any shared way between service provider and mobile device with actions being performed on both sides.

For various example embodiments, the following is applicable: An apparatus comprising means for performing the method of any of the originally filed method claims.

Still other aspects, features, and advantages of the invention are readily apparent from the following detailed description, simply by illustrating a number of particular embodiments and implementations, including the best mode contemplated for carrying out the invention. The invention is also capable of other and different embodiments, and its several details can be modified in various obvious respects, all without departing from the spirit and scope of the invention. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of the invention are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings:

FIG. **1** is a diagram of a system capable of presenting geo-traces using a reduced set of points based on an available display area, according to one embodiment;

FIG. **2** is a diagram of the components of a trace platform, according to one embodiment;

FIG. **3** is a flowchart of a process for presenting geo-traces using a reduced set of points based on an available display area, according to one embodiment;

FIG. **4** is a flowchart of a process for determining a reduced set of points, according to one embodiment;

FIG. **5** is a flowchart of a process for smoothing of geo-traces, according to one embodiment;

FIGS. **6**A-**6**D are diagrams featuring smoothing of geo-traces based on a reduced set of points, according to various embodiments;

FIGS. **7**A-**7**D are diagrams comparing a traveled route, a GPS trace, and a smoothed trace, according to various embodiments;

FIGS. **8**A and **8**B are diagrams illustrating the reduction of sharp corners associated with a geo-trace over a few pixels, according to various embodiments;

FIGS. **9**A and **9**B are diagrams featuring a side-by-side comparison of original traces and smoothed traces, according to various embodiments;

FIGS. **10**A-**10**C are further comparisons of original traces with smoothed traces, according to various embodiments;

FIGS. **11**A-**11**D are diagrams of a map user interface for presenting geo-traces using a reduced set of points based on an available display area, according to various embodiments;

FIG. **12** is a diagram of hardware that can be used to implement an embodiment of the invention;

FIG. **13** is a diagram of a chip set that can be used to implement an embodiment of the invention; and

FIG. **14** is a diagram of a mobile terminal (e.g., handset) that can be used to implement an embodiment of the invention.

DESCRIPTION OF SOME EMBODIMENTS

Examples of a method, apparatus, and computer program for presenting geo-traces using a reduced set of points based on an available display area are disclosed. In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the embodiments of the invention. It is apparent, however, to one skilled in the art that the embodiments of the invention may be practiced without these specific details or with an equivalent arrangement. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring the embodiments of the invention.

FIG. **1** is a diagram of a system capable of presenting geo-traces using a reduced set of points based on an available display area, according to one embodiment. As discussed, typical visualizations of past movements may not accurately represent the actual movements, may blur the traces of the actual movements, etc., especially when there are a lot of twists and turns associated with those movements. For example, when zoomed in deeply, sparse GPS data may lead to very hard joints in the traces, which does not accurately represent the true movements (e.g., when the movements are associated with sport activities with a lot of twists and turns). On the other hand, when zoomed out, the transversal movement of sport activities may blur the actual line and badly represent the main movements.

To address this problem, a system **100** of FIG. **1** introduces the capability to present geo-traces using a reduced set of points based on an available display area. Specifically, the system **100** may determine a reduced set of points based on an available display area of a user interface, and then cause a presentation of at least one geo-trace in the user interface based on the reduced set. It is noted that although various embodiments are described with respect to geo-traces associated with one or more movements, it is contemplated that the approach described herein may be used with other geo-traces, such as geo-traces that represent movements and/or lines in a two-dimensional and/or a three dimensional space. In one scenario, the available display area for a geo-trace associated with a river may be a 20 by 20 pixel area of a map user interface in which the visible extent of the geo-trace exists, for instance, when zoomed out. As such, the determined reduced set of points for the geo-trace may be limited to at most 400 geo-trace points (e.g., up to one point for each pixel of the pixel area even though there may be many more points for the geo-trace of the river). However, to improve performance, not all potential 400 geo-trace points may be utilized as part of the reduced set of points. In another scenario, when the user interface is zoomed in on the geo-trace associated with the river, only a portion of the geo-trace is within the available display area (e.g., the entire display area of the map user interface). As such, the visible extent of the geo-trace may only include that particular portion of the geo-trace. Thus, the geo-trace points that are outside of the available display area may not be included in the reduced set of points. As a result, only the geo-trace points that are within the available display area may be utilized for rendering the geo-trace on the map user interface.

As shown in FIG. **1**, the system **100** comprises a user equipment (UE) **101** (or multiple UEs **101***a*-**101***n*) having connectivity to a trace platform **103** via a communication network **105**. The UE **101** may include or have access to an application **107** (e.g., applications **107***a*-**107***n*) to enable the UE **101** to interact with, for instance, the trace platform **103**, which may: (1) determine a reduced set of points based on an available display area of a user interface; (2) present a geo-trace in the user interface based on the reduced set; (3) determine the available display area based on a zoom level associated with the user interface; (4) determine a threshold number of points for the presentation of the geo-trace based on the zoom level; (5) smooth out the geo-trace based on the reduced set; (6) designate the points of the reduced set as anchor points and/or other points in between the points of the reduced set as control points; (7) process the anchor points and the control points to generate one or more curves (e.g., Bezier curves); or (8) perform other functions.

In various embodiments, the trace platform **103** may include or have access to a trace database **109** to access or store trace data (e.g., GPS data of user movement, map data, etc.). The trace platform **103** may also include or have access to a profile database **111** to access or store profile information associated with users (e.g., user identification, passwords, history information of the users, etc.). Data stored in the trace database **109** and the profile database **111** may, for instance, be provided by the UEs **101**, a service platform **113**, one or more services **115** (or services **115***a*-**115***k*), one or more content providers **117** (or content providers **117***a*-**117***m*), and/or other services available over the communication network **105**. For example, a certain service **115** may gather trace data associated with users from the UEs **101** and provide the trace data to the trace database **109**. In addition, those users may register with the particular service **115**, or another service **115**, to access visualizations of geo-traces representing their movements. The registration information may then be stored as account information in the profile database **111**. It is noted that the trace platform **103** may be a separate entity of the system **100**, a part of the one or more services **115** of the service platform **113**, or included within the UE **101** (e.g., as part of the application **107**).

By way of example, the communication network **105** of system **100** includes one or more networks such as a data network, a wireless network, a telephony network, or any combination thereof. It is contemplated that the data network may be any local area network (LAN), metropolitan area network (MAN), wide area network (WAN), a public data network (e.g., the Internet), short range wireless network, or any other suitable packet-switched network, such as a commercially owned, proprietary packet-switched network, e.g., a proprietary cable or fiber-optic network, and the like, or any combination thereof. In addition, the wireless network may be, for example, a cellular network and may employ various technologies including enhanced data rates for global evolution (EDGE), general packet radio service (GPRS), global system for mobile communications (GSM), Internet protocol multimedia subsystem (IMS), universal mobile telecommunications system (UMTS), etc., as well as any other suitable wireless medium, e.g., worldwide interoperability for microwave access (WiMAX), Long Term Evolution (LTE) networks, code division multiple access (CDMA), wideband code division multiple access (WCDMA), wireless fidelity (WiFi), wireless LAN (WLAN), Bluetooth®, Internet Protocol (IP) data casting, satellite, mobile ad-hoc network (MANET), and the like, or any combination thereof.

The UE **101** is any type of mobile terminal, fixed terminal, or portable terminal including a mobile handset, station, unit, device, multimedia computer, multimedia tablet, Internet node, communicator, desktop computer, laptop computer, notebook computer, netbook computer, tablet computer, personal communication system (PCS) device, personal navigation device, personal digital assistants (PDAs), audio/video player, digital camera/camcorder, positioning device, television receiver, radio broadcast receiver, electronic book device, game device, or any combination thereof, including the accessories and peripherals of these devices, or any combination thereof. It is also contemplated that the UE **101** can support any type of interface to the user (such as "wearable" circuitry, etc.).

In another embodiment, the trace platform **103** may determine the available display area based, at least in part, on a zoom level associated with the user interface. By way of example, the available display area may be the area that contains the visible extent of a geo-trace based on the particular zoom level of the user interface. When zoomed all the way, for instance, the available display area may be a 20 by 20 pixel area that depicts the geo-trace. On the other hand, when zoomed in, the available display area may be a 400 by 400 pixel area that only depicts a portion of the geo-trace (e.g., the zoomed-in portion).

In another embodiment, the trace platform **103** may determine a threshold number of points for the presentation of the at least one geo-trace based, at least in part, on the zoom level, wherein the reduced set is further based, at least in part, on the threshold number. In certain embodiments, the reduced set may be further based on a Ramer-Douglas-Peucker algorithm, and the threshold number may represent a maximum number of points to return from the Ramer-Douglas-Peucker algorithm. In one use case, a geo-trace of a traveled route may fit within a 20 by 20 pixel area of an available display area of a map user interface when the zoom level is low (e.g., zoomed out). The 20 by 20 pixel area may, for instance, be determined by the particular zoom level. Lines connecting all of the points of the geo-trace (e.g., connected based on capture time of the geo-trace points) may, however, only overlay 100 pixels of the 20 by 20 pixel area (e.g., there may be multiple points overlaying the same pixel). As a result, the maximum number of points to return from the Ramer-Douglas-Peucker algorithm (e.g., to determine a similar trace with fewer points) may, for instance, be set at 100 geo-trace points.

In another embodiment, the trace platform **103** may cause, at least in part, a smoothing of the at least one geo-trace based, at least in part, on the reduced set, wherein the presentation of the at least one geo-trace is further based, at least in part, on the smoothing. In a further embodiment, for instance, the trace platform **103** may determine one or more other points in between the one or more points of the reduced set. The trace platform **103** may then process and/or facilitate a processing of the one or more points of the reduced set and the one or more other points to cause, at least in part, a generation of one or more curves (e.g., Bezier curves), wherein the smoothing of the at least one geo-trace is further based, at least in part, on the one or more curves.

In another embodiment, the trace platform **103** may cause, at least in part, a designation of the one or more points as one or more anchor points of one or more Bezier curves, the one or more other points as one or more control points of the one or more Bezier curves, or a combination thereof. By way of example, some of the points of the reduced set may be designated as anchor points for Bezier curves that will be rendered to present a more realistic version of the original geo-trace. New points may then be identified as control points in between the anchor points so that a Bezier algorithm can create interpolated points that create a smooth line through each anchor point.

In another embodiment, the trace platform **103** may determine that at least one of the one or more points of the reduced set are within proximity to at least one corner of the at least one geo-trace, wherein at least one of the one or more curves is based, at least in part, on the at least one of the one or more points. In one scenario, a GPS device in an automobile (e.g., the user's mobile phone, a GPS device of the automobile, etc.) may periodically collect geo-trace points to determine the traveled route of the user driving the automobile. As such, the geo-trace associated with the traveled route may include dense points when the automobile slows down, for instance, to go around a curve, to turn a corner, etc. Thus, dense points may be utilized to determine curves (as opposed to sharp corners) that more accurately reflect the traveled route of the automobile. Accordingly, in some embodiments, if it is determined that a geo-trace includes dense points near a corner of the geo-trace, the trace platform **103** may include those dense points in the reduced set of points and draw a Bezier curve between the points of the dense points that are nearest to the corner.

According to one embodiment, the smoothing of a geo-trace may include: (1) dividing the path into useful segments; (2) ensuring a certain number of control points in each segment; and (3) smoothing the geo-trace by generating Bezier curves. For illustrative purposes, an implementation of the three primary steps may, for instance, include (but is not limited to) the guidelines shown in Tables 1, 2, and 3 below:

TABLE 1

Dividing Path Into Segments
The detection of anchor points for the final line is based on pure distance. Two consecutive anchor points should have at least a minimum distance but not be more far away than two times this distance. (Factors are configurable) (1) Parameters (a) minimumDistance between two points on map (e.g., real distance between two pixel) required (b) smoothingFactor: approximate minimum number of points added per segment to smooth the curve (e.g., default: 5)

TABLE 1-continued

Dividing Path Into Segments
(c) smoothDistance: minimumDistance * smoothingFactor
(d) maximumDistance between two anchor points (e.g., default: 2 * smoothDistance)
(2) Algorithm
(a) Start of trace is by definition an anchor point (e.g., $a_1 = t_0$)
(b) Next anchor point needs to be more far away than minimumDistance
$a_n = t_j \vert \Sigma_{i=n-1}^{j}\ \mathrm{dist}(a_i, a_{i+1}) > \mathrm{smoothDistance}$
(c) If the total distance is bigger than the defined maximum distance take the last one instead: $a_n = t_{j-1}$
It is noted that, in other embodiments, a modified Kurella-Kaatz-Simplification may be utilized to detect the most significant anchor points instead of basing the identification of the anchor points on pure distance. In such embodiments, the calculation time may increase, but may also provide better results, especially on high zoomed-out levels.

TABLE 2

Ensuring Control Points
Other points between two anchor points may be considered control points. Only the most important points are taken into consideration to obtain a "nice" line without overusing processing and memory resources. At least two additional control points are added to guarantee a smooth change on each edge:
(1) Reduce control points to a small enough number
(a) First segment is from start to end (e.g., FIG. 6A)
(b) Calculate a point with the longest distance in this segment (e.g., FIG. 6A)
(c) Loop until maximum number of segments is reached or biggest epsilon < break criteria (e.g., FIG. 6C)
(i) Split segment with biggest epsilon at this point (e.g., FIG. 6B and 6C)
(ii) Recalculate epsilon in both new segments
(2) Add smooth change control points (e.g., FIG. 7B)
(a) Create a helper vector parallel to an anchor's neighbours
(b) ⅓ of length on each side is taken as distance from the anchor point on the helper line
(c) The two additional control points are added in the appropriate segments to ensure smooth edges

TABLE 3

Smoothing the Geo-Trace
For each segment, apply n^{th}-level Bezier depending to the number of control points (e.g., minimum 2^{nd}-level Bezier) (FIGS. 7A and 8A).

By way of example, the UE **101**, the trace platform **103**, the service platform **113**, the services **115**, and the content providers **117** communicate with each other and other components of the communication network **105** using well known, new or still developing protocols. In this context, a protocol includes a set of rules defining how the network nodes within the communication network **105** interact with each other based on information sent over the communication links. The protocols are effective at different layers of operation within each node, from generating and receiving physical signals of various types, to selecting a link for transferring those signals, to the format of information indicated by those signals, to identifying which software application executing on a computer system sends or receives the information. The conceptually different layers of protocols for exchanging information over a network are described in the Open Systems Interconnection (OSI) Reference Model.

Communications between the network nodes are typically effected by exchanging discrete packets of data. Each packet typically comprises (1) header information associated with a particular protocol, and (2) payload information that follows the header information and contains information that may be processed independently of that particular protocol. In some protocols, the packet includes (3) trailer information following the payload and indicating the end of the payload information. The header includes information such as the source of the packet, its destination, the length of the payload, and other properties used by the protocol. Often, the data in the payload for the particular protocol includes a header and payload for a different protocol associated with a different, higher layer of the OSI Reference Model. The header for a particular protocol typically indicates a type for the next protocol contained in its payload. The higher layer protocol is said to be encapsulated in the lower layer protocol. The headers included in a packet traversing multiple heterogeneous networks, such as the Internet, typically include a physical (layer 1) header, a data-link (layer 2) header, an internetwork (layer 3) header and a transport (layer 4) header, and various application (layer 5, layer 6 and layer 7) headers as defined by the OSI Reference Model.

FIG. **2** is a diagram of the components of a trace platform, according to one embodiment. By way of example, the trace platform **103** includes one or more components for presenting geo-traces using a reduced set of points based on an available display area. It is contemplated that the functions of these components may be combined in one or more components or performed by other components of equivalent functionality. In this embodiment, the trace platform **103** includes control logic **201**, memory **203**, a simplification module **205**, a smoothing module **207**, a presentation module **207**, an account manager **211**, and a communication interface **213**.

The control logic **201** executes at least one algorithm for executing functions of the trace platform **103**. For example, the control logic **201** may interact with the simplification module **205** to determine a reduced set of points based on an available display area of a user interface. In one use case, a GPS device may track the movements of a bicyclist by collecting location data points with respect to the bicyclist's position at various collection times (e.g., every few seconds for the duration of the bicyclist's trip). An initial geo-trace derived from the location data points and the various collection times associated with the location data points may then be supplied to the simplification module **205**, which may determine a threshold number of points based on the zoom level of the user interface for which the rendering of the geo-trace associated with the bicyclist's movements will be presented. The simplification module **205** may thereafter run a Ramer-Douglas-Peucker algorithm with the threshold number (e.g., the maximum number of points to return for the reduced set), for instance, to limit the number of points generated for the reduced set according to the threshold number.

In certain embodiments, the smoothing module **207** may determine other points (e.g., control points) in between points of the reduced set (e.g., anchor points) to generate curves to smooth out the presentation of the geo-trace associated with the bicyclist's movements. As indicated, particular points of the reduced set may be designated as anchor points for generating Bezier curves, and the identified other points between the anchor points may be designated as control points for the Bezier curves. Thereafter, the control logic **201** may direct the presentation module **209** to present the smoothed geo-trace (e.g., with the Bezier curves) in the user interface. In this way, the presentation of the geo-trace associated with the bicyclist's movements is "nice," rather than sharp and edgy, and the geo-trace more realistically represents the bicyclist's movements (e.g., bicyclists very rarely make very sharp turns).

In some embodiments, the control logic may also utilize the account manager **211** to handle registration and user access to visualizations of geo-traces. For example, in one embodiment, the geo-trace visualizations may be included as part of managed services supplied by a service provider as a hosted or a subscription-based service. As such, users may need to register and log into such services to access visualizations of geo-traces that are associated with their movements, their friends' and families' movements, etc.

The control logic **201** may additionally utilize the communication interface **213** to communicate with other components of the trace platform **103**, the UEs **101**, the service platform **113**, the services **115**, the content providers **117**, and other components of the system **100**. For example, the communication interface **213** may be utilized to receive geo-trace points of a geo-trace (e.g., from the trace database **109**, from a certain service **115**, etc.) from which a reduced set may be generated. The communication interface **213** may further include multiple means of communication. In one use case, the communication interface **213** may be able to communicate over short message service (SMS), multimedia messaging service (MMS), internet protocol, email, instant messaging, voice sessions (e.g., via a phone network), or other types of communication.

FIG. **3** is a flowchart of a process for presenting geo-traces using a reduced set of points based on an available display area, according to one embodiment. In one embodiment, the trace platform **103** performs the process **300** and is implemented in, for instance, a chip set including a processor and a memory as shown in FIG. **13**. As such, the control logic **201** can provide means for accomplishing various parts of the process **300** as well as means for accomplishing other processes in conjunction with other components of the trace platform **103**.

In step **301**, the control logic **201** may determine a reduced set of one or more points based on an available display area of a user interface. By way of example, the reduced set may be a selected subset of collected geo-trace points associated with one or more movements, one or more lines, or a combination thereof in a two-dimensional space, a three-dimensional space, or a combination thereof. In one use case, for instance, a location/navigation service may obtain location data points from a user's mobile device (e.g., a mobile phone with a GPS module) to form the full collection of geo-trace points associated with a particular traveled route of the user (e.g., while kayaking down a river). The control logic **201** may then determine the reduced set from the full collection of geo-trace points (e.g., received from the location/navigation service) based on the available display area of the user interface. As mentioned, the available display area may, for instance, be the visual extent of the geo-trace associated with the traveled route on the user interface. Thereafter, in step **303**, the control logic **201** may cause a presentation of at least one geo-trace in the user interface based on the reduced set.

FIG. **4** is a flowchart of a process for determining a reduced set of points, according to one embodiment. In one embodiment, the trace platform **103** performs the process **400** and is implemented in, for instance, a chip set including a processor and a memory as shown in FIG. **13**. As such, the control logic **201** can provide means for accomplishing various parts of the process **400** as well as means for accomplishing other processes in conjunction with other components of the trace platform **103**.

In step **401**, the control logic **201** may determine the available display area for the presentation of the geo-trace based on a zoom level associated with the user interface. In one use case, a map user interface may be set to a low zoom level (e.g., zoomed out). As such, based on the zoom level, the available display area may be a particular 20 by 20 pixel area on the user interface since the visual extent of the geo-trace is determined to be within that 20 by 20 pixel area. Moreover, at step **403**, the control logic **201** may determine a threshold number of points for the presentation of the at least one geo-trace based on the zoom level. By way of example, the threshold number of points may be determined to be 50 points the zoom level is 3 (e.g., 3 notches away from the farthest zoomed-out notch), 60 points when the zoom level is 5, etc. In some embodiments, the size of the geo-trace (e.g., actual dimensions) may be considered along with the zoom level to determine the threshold number of points.

In step **405**, the control logic **201** may determine the reduced set of the one or more points based on the available display area and the threshold number. As discussed, in certain embodiments, the reduced set may be further based on a Ramer-Douglas-Peucker algorithm, and the threshold number may represent a maximum number of points to return from the Ramer-Douglas-Peucker algorithm. As an example, when the zoom level is 5, the threshold number may be 60 points and only a portion of a geo-trace may be within the available display area. As input parameters, the Ramer-Douglas-Peucker algorithm may be modified to take the maximum number of points to return (e.g., 60 points) and a subset of the original geo-trace points that are part of the portion of the geo-trace within the available display area. In this way, resources utilization (e.g., time, processing power, and memory) associated with calculating the reduced set may be significantly decreased.

FIG. **5** is a flowchart of a process for smoothing of geo-traces, according to one embodiment. In one embodiment, the trace platform **103** performs the process **500** and is implemented in, for instance, a chip set including a processor and a memory as shown in FIG. **13**. As such, the control logic **201** can provide means for accomplishing various parts of the process **500** as well as means for accomplishing other processes in conjunction with other components of the trace platform **103**.

In step **501**, the control logic **201** may determine one or more other points in between the one or more points of the reduced set. As illustrated in step **503**, some of the one or more points of the reduced set may then be designated as one or more anchor points of one or more Bezier curves, while some of the one or more other points may be designated as one or more control points of the one or more Bezier curves.

In step **505**, the control logic **201** may process and/or facilitate a processing of the one or more anchor points and the one or more control points to cause a generation of the one or more Bezier curves. The control logic **201** may then, at step **507**, cause a smoothing of the at least one geo-trace based on the one or more Bezier curves. By way of example, the one or more Bezier curves may replace segments of the at least one trace to form a smoother geo-trace that more accurately reflects the movements and/or lines that the at least geo-trace represents.

FIGS. **6**A-**6**D are diagrams featuring smoothing of geo-traces based on a reduced set of points, according to various embodiments. As shown, FIGS. **6**A-**6**D includes an initial geo-trace **601** having at least 9 points (e.g., at least one point for each sharp corner). As indicated, in some embodiments, the initial geo-trace **601** and a maximum number of points may be input parameters to a simplification algorithm (e.g., Ramer-Douglas-Peucker algorithm), for instance, to instruct the simplification algorithm to return up to the specified maximum number of points. For illustrative purposes, in FIGS. **6**A-**6**D, the maximum number of points may be set to 4 based on a particular zoom level. As depicted in FIG. **6**A, the algorithm may first determine that the most relevant points of the initial geo-trace **601** are points **603***a* and **603***b*, forming an initial segment **605** (e.g., based on the guidelines in Tables 1 and 2).

In FIG. **6**B, the algorithm may then determine that point **603***c* is the next most relevant point of the initial geo-trace **601**, forming segments **607***a* and **607***b* (e.g., based on the guidelines in Tables 1 and 2). In FIG. **6**C, point **603***d* may be determined to be the next most relevant point of the initial geo-trace **601**, forming segments **609***a* and **609***b*. The algorithm may then return points **603***a*-**603***d* since the specified maximum number of points (e.g., 4 points) has been reached. Thereafter, in FIG. **6**D, smoothing (e.g., Bezier smoothing) of the geo-trace having segments **607***b*, **609***a*, and **609***b* may be performed so that the presentation of the geo-trace may include curves **611** in place of the segments **609***a* and **609***b* (e.g., based on the guidelines in Tables 1, 2, and 3).

FIGS. **7**A-**7**D are diagrams comparing a traveled route, a GPS trace, and a smoothed trace, according to various embodiments. In FIG. **7**A, GPS data points **701** associated with traveled route **703** may be collected as the user is traversing the traveled route **703** (e.g., the user may be carrying a GPS device). As illustrated, however, the GPS trace **705** does not accurately represent the traveled route **703**. As shown, in FIG. **7**B, GPS data points **701** may be utilized as anchor points, and control points **707** may be identified according to those anchor points (e.g., based on the guidelines in Tables 1 and 2). Thus, the location data points **701** and the control points **707** may be utilized to create the smoothed trace **709** (e.g., based on the guidelines in Tables 1, 2, and 3) which more accurately represents the traveled route **703**. Moreover, FIGS. **7**C and **7**D provides additional comparisons between the traveled route **703**, the GPS trace **705**, and the smoothed trace **709**.

FIGS. **8**A and **8**B are diagrams illustrating the reduction of sharp corners associated with a geo-trace over a few pixels, according to various embodiments. As shown, in FIG. **8**A, an edgy trace **801** (e.g., a sparse GPS trace) overlays a number of pixels. In this scenario, a new trace **805** may then be formed from 4 trace points returned from a simplification algorithm (e.g., a Ramer-Douglas-Peucker algorithm) that took as inputs: (1) a threshold number indicating that the maximum number of points to return is 4; and (2) the collected data points of the edgy trace **801**. Thereafter, various control points **807** may be identified (e.g., based on anchor points returned from the simplification algorithm), and then utilized to form the smoothed trace **809**. For comparison purposes, FIG. **8**B illustrates the edgy trace **801** next to the smoothed trace **809**.

FIGS. **9**A and **9**B are diagrams featuring a side-by-side comparison of original trace and smoothed traces, according to various embodiments. As shown, in FIG. **9**A, user interface **901** depicts a satellite view of original traces **903***a* and **903***b* (e.g., GPS traces) at a particular zoom level (e.g., zoom indicator **905**). In FIG. **9**B, the user interface **901** depicts smooth traces **907***a* and **907***b* derived from original traces **903***a* and **903***b* (e.g., based on the guidelines in Tables 1, 2, and 3).

FIGS. **10**A-**10**C are further comparisons of original traces with smoothed traces, according to various embodiments. For example, FIG. **10**A illustrates original traces **903***a* and **903***b* (e.g., sparse GPS traces) alongside smoothed traces **907***a* and **907***b*. FIG. **10**B illustrates original traces **1001***a*-**1001***c* alongside smoothed traces **1003***a*-**1003***c*. FIG. **10**C illustrates original traces **1005***a*-**1005***c* alongside smoothed traces **1007***a*-**1007***c*.

FIGS. **11**A-**11**D are diagrams of a map user interface for presenting geo-traces using a reduced set of points based on an available display area, according to various embodiments. As shown, FIG. **11**A illustrates a user interface **1101** depicting smoothed traces **1103** and **1105**. As indicated, the smoothed traces **1103** and **1105** may be derived from original GPS traces associated with traveled paths (e.g., based on the guidelines in Tables 1, 2, and 3) according to the zoom level. In addition, FIG. **11**A illustrates a zoom indicator **1107**, which enables the user to zoom in on a particular area of the user interface **1101**. FIG. **11**B illustrates the result of the user zooming in on top portion of the smoothed trace **1103**. Based on the new zoom level and the new visual extent of the traveled paths, smoothed traces **1109** and **1111** are derived from portions of the original traces (e.g., generated on-the-fly based on the new zoom level, pre-generated based on the particular zoom level, etc.). As depicted, the smoothed traces **1109** and **1111** demonstrate more details than the smoothed traces **1103** and **1105** (e.g., what used to be depicted as an almost straight line now has curves).

FIG. **11**C illustrates the result of the user zooming in on a portion of the smoothed trace **1109**. Based on the new zoom level and the new visual extent, smoothed trace **1113** is derived from a portion of the original trace associated with the smoothed traces **1103** and **1109**. As depicted, the smoothed trace **1113** provides more details with respect to the traveled path than the smoothed trace **1109**. Finally, FIG. **11**D illustrates the result of the user zooming in on a portion of the smoothed trace **1113**. Again, the smoothed trace **1115** is derived from a portion of the original trace associated with the smoothed traces **1103**, **1109**, and **1113** based on the new zoom level and the new visual extent. As shown, the smoothed trace **1115** demonstrates additional curves in the original trace that were not provided by the smoothed traces **1103**, **1109**, and **1113**.

The processes described herein for presenting geo-traces using a reduced set of points based on an available display area may be advantageously implemented via software, hardware, firmware or a combination of software and/or firmware and/or hardware. For example, the processes described herein, may be advantageously implemented via processor(s), Digital Signal Processing (DSP) chip, an Application Specific Integrated Circuit (ASIC), Field Programmable Gate Arrays (FPGAs), etc. Such exemplary hardware for performing the described functions is detailed below.

FIG. **12** illustrates a computer system **1200** upon which an embodiment of the invention may be implemented. Although computer system **1200** is depicted with respect to a particular device or equipment, it is contemplated that other devices or equipment (e.g., network elements, servers, etc.) within FIG. **12** can deploy the illustrated hardware and components of system **1200**. Computer system **1200** is programmed (e.g., via computer program code or instructions) to present geo-traces using a reduced set of points based on an available display area as described herein and includes a communication mechanism such as a bus **1210** for passing information between other internal and external components of the computer system **1200**. Information (also called data) is represented as a physical expression of a measurable phenomenon, typically electric voltages, but including, in other embodiments, such phenomena as magnetic, electromagnetic, pressure, chemical, biological, molecular, atomic, sub-atomic and quantum interactions. For example, north and south magnetic fields, or a zero and non-zero electric voltage, represent two states (0, 1) of a binary digit (bit). Other phenomena can represent digits of a higher base. A superposition of multiple simultaneous quantum states before measurement represents a quantum bit (qubit). A sequence of one or more digits constitutes digital data that is used to represent a number or code for a character. In some embodiments, information called analog data is represented by a near continuum of measurable values within a particular range. Computer system **1200**, or a portion thereof, constitutes a means for performing one or more steps of presenting geo-traces using a reduced set of points based on an available display area.

A bus **1210** includes one or more parallel conductors of information so that information is transferred quickly among devices coupled to the bus **1210**. One or more processors **1202** for processing information are coupled with the bus **1210**.

A processor (or multiple processors) **1202** performs a set of operations on information as specified by computer program code related to presenting geo-traces using a reduced set of points based on an available display area. The computer program code is a set of instructions or statements providing instructions for the operation of the processor and/or the computer system to perform specified functions. The code, for example, may be written in a computer programming language that is compiled into a native instruction set of the processor. The code may also be written directly using the native instruction set (e.g., machine language). The set of operations include bringing information in from the bus **1210** and placing information on the bus **1210**. The set of operations also typically include comparing two or more units of information, shifting positions of units of information, and combining two or more units of information, such as by addition or multiplication or logical operations like OR, exclusive OR (XOR), and AND. Each operation of the set of operations that can be performed by the processor is represented to the processor by information called instructions, such as an operation code of one or more digits. A sequence of operations to be executed by the processor **1202**, such as a sequence of operation codes, constitute processor instructions, also called computer system instructions or, simply, computer instructions. Processors may be implemented as mechanical, electrical, magnetic, optical, chemical, or quantum components, among others, alone or in combination.

Computer system **1200** also includes a memory **1204** coupled to bus **1210**. The memory **1204**, such as a random access memory (RAM) or any other dynamic storage device, stores information including processor instructions for presenting geo-traces using a reduced set of points based on an available display area. Dynamic memory allows information stored therein to be changed by the computer system **1200**. RAM allows a unit of information stored at a location called a memory address to be stored and retrieved independently of information at neighboring addresses. The memory **1204** is also used by the processor **1202** to store temporary values during execution of processor instructions. The computer system **1200** also includes a read only memory (ROM) **1206** or any other static storage device coupled to the bus **1210** for storing static information, including instructions, that is not changed by the computer system **1200**. Some memory is composed of volatile storage that loses the information stored thereon when power is lost. Also coupled to bus **1210** is a non-volatile (persistent) storage device **1208**, such as a magnetic disk, optical disk or flash card, for storing information, including instructions, that persists even when the computer system **1200** is turned off or otherwise loses power.

Information, including instructions for presenting geo-traces using a reduced set of points based on an available display area, is provided to the bus **1210** for use by the processor from an external input device **1212**, such as a keyboard containing alphanumeric keys operated by a human user, a microphone, an Infrared (IR) remote control, a joystick, a game pad, a stylus pen, a touch screen, or a sensor. A sensor detects conditions in its vicinity and transforms those detections into physical expression compatible with the measurable phenomenon used to represent information in computer system **1200**. Other external devices coupled to bus **1210**, used primarily for interacting with humans, include a display device **1214**, such as a cathode ray tube (CRT), a liquid crystal display (LCD), a light emitting diode (LED) display, an organic LED (OLED) display, a plasma screen, or a printer for presenting text or images, and a pointing device **1216**, such as a mouse, a trackball, cursor direction keys, or a motion sensor, for controlling a position of a small cursor image presented on the display **1214** and issuing commands associated with graphical elements presented on the display **1214**, and one or more camera sensors **1294** for capturing, recording and causing to store one or more still and/or moving images (e.g., videos, movies, etc.) which also may comprise audio recordings. In some embodiments, for example, in embodiments in which the computer system **1200** performs all functions automatically without human input, one or more of external input device **1212**, display device **1214** and pointing device **1216** may be omitted.

In the illustrated embodiment, special purpose hardware, such as an application specific integrated circuit (ASIC) **1220**, is coupled to bus **1210**. The special purpose hardware is configured to perform operations not performed by processor **1202** quickly enough for special purposes. Examples of ASICs include graphics accelerator cards for generating images for display **1214**, cryptographic boards for encrypting and decrypting messages sent over a network, speech recognition, and interfaces to special external devices, such as robotic arms and medical scanning equipment that repeatedly perform some complex sequence of operations that are more efficiently implemented in hardware.

Computer system **1200** also includes one or more instances of a communications interface **1270** coupled to bus **1210**. Communication interface **1270** provides a one-way or two-way communication coupling to a variety of external devices that operate with their own processors, such as printers, scanners and external disks. In general the coupling is with a network link **1278** that is connected to a local network **1280** to which a variety of external devices with their own processors are connected. For example, communication interface **1270** may be a parallel port or a serial port or a universal serial bus (USB) port on a personal computer. In some embodiments, communications interface **1270** is an integrated services digital network (ISDN) card or a digital subscriber line (DSL) card or a telephone modem that provides an information communication connection to a corresponding type of telephone line. In some embodiments, a communication interface **1270** is a cable modem that converts signals on bus **1210** into signals for a communication connection over a coaxial cable or into optical signals for a communication connection over a fiber optic cable. As another example, communications interface **1270** may be a local area network (LAN) card to provide a data communication connection to a compatible LAN, such as Ethernet. Wireless links may also be implemented. For wireless links, the communications interface **1270** sends or receives or both sends and receives electrical, acoustic or electromagnetic signals, including infrared and optical signals, that carry information streams, such as digital data. For example, in wireless handheld devices, such as mobile telephones like cell phones, the communications interface **1270** includes a radio band electromagnetic transmitter and receiver called a radio transceiver. In certain embodiments, the communications interface **1270** enables connection to the communication network **105** for presenting geo-traces using a reduced set of points based on an available display area to the UE **101**.

The term "computer-readable medium" as used herein refers to any medium that participates in providing information to processor **1202**, including instructions for execution. Such a medium may take many forms, including, but not limited to computer-readable storage medium (e.g., non-volatile media, volatile media), and transmission media. Non-transitory media, such as non-volatile media, include, for example, optical or magnetic disks, such as storage device **1208**. Volatile media include, for example, dynamic memory **1204**. Transmission media include, for example, twisted pair cables, coaxial cables, copper wire, fiber optic cables, and carrier waves that travel through space without wires or cables, such as acoustic waves and electromagnetic waves, including radio, optical and infrared waves. Signals include man-made transient variations in amplitude, frequency, phase, polarization or other physical properties transmitted through the transmission media. Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, any other magnetic medium, a CD-ROM, CDRW, DVD, any other optical medium, punch cards, paper tape, optical mark sheets, any other physical medium with patterns of holes or other optically recognizable indicia, a RAM, a PROM, an EPROM, a FLASH-EPROM, an EEPROM, a flash memory, any other memory chip or cartridge, a carrier wave, or any other medium from which a computer can read. The term computer-readable storage medium is used herein to refer to any computer-readable medium except transmission media.

Logic encoded in one or more tangible media includes one or both of processor instructions on a computer-readable storage media and special purpose hardware, such as ASIC **1220**.

Network link **1278** typically provides information communication using transmission media through one or more networks to other devices that use or process the information. For example, network link **1278** may provide a connection through local network **1280** to a host computer **1282** or to equipment **1284** operated by an Internet Service Provider (ISP). ISP equipment **1284** in turn provides data communication services through the public, world-wide packet-switching communication network of networks now commonly referred to as the Internet **1290**.

A computer called a server host **1292** connected to the Internet hosts a process that provides a service in response to information received over the Internet. For example, server host **1292** hosts a process that provides information representing video data for presentation at display **1214**. It is contemplated that the components of system **1200** can be deployed in various configurations within other computer systems, e.g., host **1282** and server **1292**.

At least some embodiments of the invention are related to the use of computer system **1200** for implementing some or all of the techniques described herein. According to one embodiment of the invention, those techniques are performed by computer system **1200** in response to processor **1202** executing one or more sequences of one or more processor instructions contained in memory **1204**. Such instructions, also called computer instructions, software and program code, may be read into memory **1204** from another computer-readable medium such as storage device **1208** or network link **1278**. Execution of the sequences of instructions contained in memory **1204** causes processor **1202** to perform one or more of the method steps described herein. In alternative embodiments, hardware, such as ASIC **1220**, may be used in place of or in combination with software to implement the invention. Thus, embodiments of the invention are not limited to any specific combination of hardware and software, unless otherwise explicitly stated herein.

The signals transmitted over network link **1278** and other networks through communications interface **1270**, carry information to and from computer system **1200**. Computer system **1200** can send and receive information, including program code, through the networks **1280**, **1290** among others, through network link **1278** and communications interface **1270**. In an example using the Internet **1290**, a server host **1292** transmits program code for a particular application, requested by a message sent from computer **1200**, through Internet **1290**, ISP equipment **1284**, local network **1280** and communications interface **1270**. The received code may be executed by processor **1202** as it is received, or may be stored in memory **1204** or in storage device **1208** or any other non-volatile storage for later execution, or both. In this manner, computer system **1200** may obtain application program code in the form of signals on a carrier wave.

Various forms of computer readable media may be involved in carrying one or more sequence of instructions or data or both to processor **1202** for execution. For example, instructions and data may initially be carried on a magnetic disk of a remote computer such as host **1282**. The remote computer loads the instructions and data into its dynamic memory and sends the instructions and data over a telephone line using a modem. A modem local to the computer system **1200** receives the instructions and data on a telephone line and uses an infra-red transmitter to convert the instructions and data to a signal on an infra-red carrier wave serving as the network link **1278**. An infrared detector serving as communications interface **1270** receives the instructions and data carried in the infrared signal and places information representing the instructions and data onto bus **1210**. Bus **1210** carries the information to memory **1204** from which processor **1202** retrieves and executes the instructions using some of the data sent with the instructions. The instructions and data received in memory **1204** may optionally be stored on storage device **1208**, either before or after execution by the processor **1202**.

FIG. **13** illustrates a chip set or chip **1300** upon which an embodiment of the invention may be implemented. Chip set **1300** is programmed to present geo-traces using a reduced set of points based on an available display area as described herein and includes, for instance, the processor and memory components described with respect to FIG. **12** incorporated in one or more physical packages (e.g., chips). By way of example, a physical package includes an arrangement of one or more materials, components, and/or wires on a structural assembly (e.g., a baseboard) to provide one or more characteristics such as physical strength, conservation of size, and/or limitation of electrical interaction. It is contemplated that in certain embodiments the chip set **1300** can be implemented in a single chip. It is further contemplated that in certain embodiments the chip set or chip **1300** can be implemented as a single "system on a chip." It is further contemplated that in certain embodiments a separate ASIC would not be used, for example, and that all relevant functions as disclosed herein would be performed by a processor or processors. Chip set or chip **1300**, or a portion thereof, constitutes a means for performing one or more steps of providing user interface navigation information associated with the availability of functions. Chip set or chip **1300**, or a portion thereof, constitutes a means for performing one or more steps of presenting geo-traces using a reduced set of points based on an available display area.

In one embodiment, the chip set or chip **1300** includes a communication mechanism such as a bus **1301** for passing information among the components of the chip set **1300**. A processor **1303** has connectivity to the bus **1301** to execute instructions and process information stored in, for example, a memory **1305**. The processor **1303** may include one or more processing cores with each core configured to perform independently. A multi-core processor enables multiprocessing within a single physical package. Examples of a multi-core processor include two, four, eight, or greater numbers of processing cores. Alternatively or in addition, the processor **1303** may include one or more microprocessors configured in tandem via the bus **1301** to enable independent execution of instructions, pipelining, and multithreading. The processor **1303** may also be accompanied with one or more specialized components to perform certain processing functions and tasks such as one or more digital signal processors (DSP) **1307**, or one or more application-specific integrated circuits (ASIC) **1309**. A DSP **1307** typically is configured to process real-world signals (e.g., sound) in real time independently of the processor **1303**. Similarly, an ASIC **1309** can be configured to performed specialized functions not easily performed by a more general purpose processor. Other specialized components to aid in performing the inventive functions described herein may include one or more field programmable gate arrays (FPGA), one or more controllers, or one or more other special-purpose computer chips.

In one embodiment, the chip set or chip **1300** includes merely one or more processors and some software and/or firmware supporting and/or relating to and/or for the one or more processors.

The processor **1303** and accompanying components have connectivity to the memory **1305** via the bus **1301**. The memory **1305** includes both dynamic memory (e.g., RAM, magnetic disk, writable optical disk, etc.) and static memory (e.g., ROM, CD-ROM, etc.) for storing executable instructions that when executed perform the inventive steps described herein to present geo-traces using a reduced set of points based on an available display area. The memory **1305** also stores the data associated with or generated by the execution of the inventive steps.

FIG. **14** is a diagram of exemplary components of a mobile terminal (e.g., handset) for communications, which is capable of operating in the system of FIG. **1**, according to one embodiment. In some embodiments, mobile terminal **1401**, or a portion thereof, constitutes a means for performing one or more steps of presenting geo-traces using a reduced set of points based on an available display area. Generally, a radio receiver is often defined in terms of front-end and back-end characteristics. The front-end of the receiver encompasses all of the Radio Frequency (RF) circuitry whereas the back-end encompasses all of the base-band processing circuitry. As used in this application, the term "circuitry" refers to both: (1) hardware-only implementations (such as implementations in only analog and/or digital circuitry), and (2) to combinations of circuitry and software (and/or firmware) (such as, if applicable to the particular context, to a combination of processor(s), including digital signal processor(s), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions). This definition of "circuitry" applies to all uses of this term in this application, including in any claims. As a further example, as used in this application and if applicable to the particular context, the term "circuitry" would also cover an implementation of merely a processor (or multiple processors) and its (or their) accompanying software/or firmware. The term "circuitry" would also cover if applicable to the particular context, for example, a baseband integrated circuit or applications processor integrated circuit in a mobile phone or a similar integrated circuit in a cellular network device or other network devices.

Pertinent internal components of the telephone include a Main Control Unit (MCU) **1403**, a Digital Signal Processor (DSP) **1405**, and a receiver/transmitter unit including a microphone gain control unit and a speaker gain control unit. A main display unit **1407** provides a display to the user in support of various applications and mobile terminal functions that perform or support the steps of presenting geo-traces using a reduced set of points based on an available display area. The display **1407** includes display circuitry configured to display at least a portion of a user interface of the mobile terminal (e.g., mobile telephone). Additionally, the display **1407** and display circuitry are configured to facilitate user control of at least some functions of the mobile terminal. An audio function circuitry **1409** includes a microphone **1411** and microphone amplifier that amplifies the speech signal output from the microphone **1411**. The amplified speech signal output from the microphone **1411** is fed to a coder/decoder (CODEC) **1413**.

A radio section **1415** amplifies power and converts frequency in order to communicate with a base station, which is included in a mobile communication system, via antenna **1417**. The power amplifier (PA) **1419** and the transmitter/modulation circuitry are operationally responsive to the MCU **1403**, with an output from the PA **1419** coupled to the duplexer **1421** or circulator or antenna switch, as known in the art. The PA **1419** also couples to a battery interface and power control unit **1420**.

In use, a user of mobile terminal **1401** speaks into the microphone **1411** and his or her voice along with any detected background noise is converted into an analog voltage. The analog voltage is then converted into a digital signal through the Analog to Digital Converter (ADC) **1423**. The control unit **1403** routes the digital signal into the DSP **1405** for processing therein, such as speech encoding, channel encoding, encrypting, and interleaving. In one embodiment, the processed voice signals are encoded, by units not separately shown, using a cellular transmission protocol such as enhanced data rates for global evolution (EDGE), general packet radio service (GPRS), global system for mobile communications (GSM), Internet protocol multimedia subsystem (IMS), universal mobile telecommunications system (UMTS), etc., as well as any other suitable wireless medium, e.g., microwave access (WiMAX), Long Term Evolution (LTE) networks, code division multiple access (CDMA), wideband code division multiple access (WCDMA), wireless fidelity (WiFi), satellite, and the like, or any combination thereof.

The encoded signals are then routed to an equalizer **1425** for compensation of any frequency-dependent impairments that occur during transmission though the air such as phase and amplitude distortion. After equalizing the bit stream, the modulator **1427** combines the signal with a RF signal generated in the RF interface **1429**. The modulator **1427** generates a sine wave by way of frequency or phase modulation. In order to prepare the signal for transmission, an up-converter **1431** combines the sine wave output from the modulator **1427** with another sine wave generated by a synthesizer **1433** to achieve the desired frequency of transmission. The signal is then sent through a PA **1419** to increase the signal to an appropriate power level. In practical systems, the PA **1419** acts as a variable gain amplifier whose gain is controlled by the DSP **1405** from information received from a network base station. The signal is then filtered within the duplexer **1421** and optionally sent to an antenna coupler **1435** to match impedances to provide maximum power transfer. Finally, the signal is transmitted via antenna **1417** to a local base station. An automatic gain control (AGC) can be supplied to control the gain of the final stages of the receiver. The signals may be forwarded from there to a remote telephone which may be another cellular telephone, any other mobile phone or a land-line connected to a Public Switched Telephone Network (PSTN), or other telephony networks.

Voice signals transmitted to the mobile terminal **1401** are received via antenna **1417** and immediately amplified by a low noise amplifier (LNA) **1437**. A down-converter **1439** lowers the carrier frequency while the demodulator **1441** strips away the RF leaving only a digital bit stream. The signal then goes through the equalizer **1425** and is processed by the DSP **1405**. A Digital to Analog Converter (DAC) **1443** converts the signal and the resulting output is transmitted to the user through the speaker **1445**, all under control of a Main Control Unit (MCU) **1403** which can be implemented as a Central Processing Unit (CPU).

The MCU **1403** receives various signals including input signals from the keyboard **1447**. The keyboard **1447** and/or the MCU **1403** in combination with other user input components (e.g., the microphone **1411**) comprise a user interface circuitry for managing user input. The MCU **1403** runs a user interface software to facilitate user control of at least some functions of the mobile terminal **1401** to present geo-traces using a reduced set of points based on an available display area. The MCU **1403** also delivers a display command and a switch command to the display **1407** and to the speech output switching controller, respectively. Further, the MCU **1403** exchanges information with the DSP **1405** and can access an optionally incorporated SIM card **1449** and a memory **1451**. In addition, the MCU **1403** executes various control functions required of the terminal. The DSP **1405** may, depending upon the implementation, perform any of a variety of conventional digital processing functions on the voice signals. Additionally, DSP **1405** determines the background noise level of the local environment from the signals detected by microphone **1411** and sets the gain of microphone **1411** to a level selected to compensate for the natural tendency of the user of the mobile terminal **1401**.

The CODEC **1413** includes the ADC **1423** and DAC **1443**. The memory **1451** stores various data including call incoming tone data and is capable of storing other data including music data received via, e.g., the global Internet. The software module could reside in RAM memory, flash memory, registers, or any other form of writable storage medium known in the art. The memory device **1451** may be, but not limited to, a single memory, CD, DVD, ROM, RAM, EEPROM, optical storage, magnetic disk storage, flash memory storage, or any other non-volatile storage medium capable of storing digital data.

An optionally incorporated SIM card **1449** carries, for instance, important information, such as the cellular phone number, the carrier supplying service, subscription details, and security information. The SIM card **1449** serves primarily to identify the mobile terminal **1401** on a radio network. The card **1449** also contains a memory for storing a personal telephone number registry, text messages, and user specific mobile terminal settings.

Further, one or more camera sensors **1453** may be incorporated onto the mobile station **1401** wherein the one or more camera sensors may be placed at one or more locations on the mobile station. Generally, the camera sensors may be utilized to capture, record, and cause to store one or more still and/or moving images (e.g., videos, movies, etc.) which also may comprise audio recordings.

While the invention has been described in connection with a number of embodiments and implementations, the invention is not so limited but covers various obvious modifications and equivalent arrangements, which fall within the purview of the appended claims. Although features of the invention are expressed in certain combinations among the claims, it is contemplated that these features can be arranged in any combination and order.

What is claimed is:

1. A method comprising facilitating a processing of and/or processing (1) data and/or (2) information and/or (3) at least one signal, the (1) data and/or (2) information and/or (3) at least one signal based, at least in part, on the following:

at least one determination of a reduced set of one or more points based on an available display area of a user interface;

a presentation of at least one geo-trace in the user interface based, at least in part, on the reduced set; and

a smoothing of the at least one geo-trace based, at least in part, on the reduced set,

wherein the presentation of the at least one geo-trace is further based, at least in part, on the smoothing,

wherein the at least one geo-trace is derived from positioning system data points collected as a user traverses a traveled route carrying a positioning device,

wherein the positioning system data points are utilized as anchor points and control points are identified according to the anchor points, and

wherein the positioning system data points and the control points are utilized to create a smoothed trace in the smoothing of the at least one geo-trace based.

2. A method of claim **1**, wherein the (1) data and/or (2) information and/or (3) at least one signal are further based, at least in part, on the following:

at least one determination of the available display area based, at least in part, on a zoom level associated with the user interface.

3. A method of claim 2, wherein the (1) data and/or (2) information and/or (3) at least one signal are further based, at least in part, on the following:

at least one determination of a threshold number of points for the presentation of the at least one geo-trace based, at least in part, on the zoom level,

wherein the reduced set is further based, at least in part, on the threshold number.

4. A method of claim 3, wherein the reduced set is further based, at least in part, on a Ramer-Douglas-Peucker algorithm, and wherein the threshold number represents a maximum number of points to return from the Ramer-Douglas-Peucker algorithm.

5. A method of claim 1, wherein the (1) data and/or (2) information and/or (3) at least one signal are further based, at least in part, on the following:

at least one determination of one or more other points in between the one or more points of the reduced set; and

a processing of the one or more points of the reduced set and the one or more other points to cause, at least in part, a generation of one or more curves,

wherein the smoothing of the at least one geo-trace is further based, at least in part, on the one or more curves.

6. A method of claim 5, wherein the one or more curves include, at least in part, one or more Bezier curves, and wherein the (1) data and/or (2) information and/or (3) at least one signal are further based, at least in part, on the following:

a designation of the one or more points as one or more anchor points of the one or more Bezier curves, the one or more other points as one or more control points of the one or more Bezier curves, or a combination thereof.

7. A method of claim 5, wherein the (1) data and/or (2) information and/or (3) at least one signal are further based, at least in part, on the following:

at least one determination that at least one of the one or more points of the reduced set are within proximity to at least one corner of the at least one geo-trace,

wherein at least one of the one or more curves is based, at least in part, on the at least one of the one or more points.

8. A method of claim 1, wherein the at least one geo-trace represents one or more movements, one or more lines, or a combination thereof in a two-dimensional space, a three-dimensional space, or a combination thereof.

9. An apparatus comprising:

at least one processor; and

at least one memory including computer program code for one or more programs,

the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus to perform at least the following,

determine a reduced set of one or more points based on an available display area of a user interface;

cause, at least in part, a presentation of at least one geo-trace in the user interface based, at least in part, on the reduced set; and

cause, at least in part, a smoothing of the at least one geo-trace based, at least in part, on the reduced set,

wherein the presentation of the at least one geo-trace is further based, at least in part, on the smoothing,

wherein the at least one geo-trace is derived from positioning system data points collected as a user traverses a traveled route carrying a positioning device,

wherein the positioning system data points are utilized as anchor points and control points are identified according to the anchor points, and

wherein the positioning system data points and the control points are utilized to create a smoothed trace in the smoothing of the at least one geo-trace based.

10. An apparatus of claim 9, wherein the apparatus is further caused to:

determine the available display area based, at least in part, on a zoom level associated with the user interface.

11. An apparatus of claim 10, wherein the apparatus is further caused to:

determine a threshold number of points for the presentation of the at least one geo-trace based, at least in part, on the zoom level,

wherein the reduced set is further based, at least in part, on the threshold number.

12. An apparatus of claim 11, wherein the reduced set is further based, at least in part, on a Ramer-Douglas-Peucker algorithm, and wherein the threshold number represents a maximum number of points to return from the Ramer-Douglas-Peucker algorithm.

13. An apparatus of claim 9, wherein the apparatus is further caused to:

determine one or more other points in between the one or more points of the reduced set; and

process and/or facilitate a processing of the one or more points of the reduced set and the one or more other points to cause, at least in part, a generation of one or more curves,

wherein the smoothing of the at least one geo-trace is further based, at least in part, on the one or more curves.

14. An apparatus of claim 13, wherein the one or more curves include, at least in part, one or more Bezier curves, and wherein the apparatus is further caused to:

cause, at least in part, a designation of the one or more points as one or more anchor points of the one or more Bezier curves, the one or more other points as one or more control points of the one or more Bezier curves, or a combination thereof.

15. An apparatus of claim 13, wherein the apparatus is further caused to:

determine that at least one of the one or more points of the reduced set are within proximity to at least one corner of the at least one geo-trace,

wherein at least one of the one or more curves is based, at least in part, on the at least one of the one or more points.

16. An apparatus of claim 9, wherein the at least one geo-trace represents one or more movements, one or more lines, or a combination thereof in a two-dimensional space, a three-dimensional space, or a combination thereof.

17. A non-transitory computer-readable storage medium carrying one or more sequences of one or more instructions which, when executed by one or more processors, cause an apparatus to at least perform the following steps:

determining a reduced set of one or more points based on an available display area of a user interface;

causing, at least in part, a presentation of at least one geo-trace in the user interface based, at least in part, on the reduced set; and

causing, at least in part, a smoothing of the at least one geo-trace based, at least in part, on the reduced set,

wherein the presentation of the at least one geo-trace is further based, at least in part, on the smoothing,

wherein the at least one geo-trace is derived from positioning system data points collected as a user traverses a traveled route carrying a positioning device,

wherein the positioning system data points are utilized as anchor points and control points are identified according to the anchor points, and wherein the positioning system data points and the control points are utilized to create a smoothed trace in the smoothing of the at least one geo-trace based.

18. A non-transitory computer-readable storage medium of claim **17**, wherein the apparatus is caused to further perform:

determining the available display area based, at least in part, on a zoom level associated with the user interface; and

determining a threshold number of points for the presentation of the at least one geo-trace based, at least in part, on the zoom level,

wherein the reduced set is further based, at least in part, on the threshold number.

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